

Amendment to the Drawing

The attached sheets of Drawings includes Amendments to Figures 2-12. As requested by the Examiner, original Figures 2 and 4 were removed from the Drawing and are now included in the specification as Appendices G and H, respectively. The remaining Figures 3 and 5-12 were renumbered as Figures 2-10, so that figures are continuously numbered.

Attachment: Replacement Sheets

Remarks

Claims 50-69 and 82-106 are pending in the application. Claims 53, 54, 57, and 58 have been withdrawn from consideration by the Examiner. Claims 50-52, 55, 56, 59-69, and 82-106 are rejected by the Examiner.

Claims 50-95 have been canceled. Claims 96, 97, 100, 101, 104, 105, and 106 have been amended, and new claim 107 has been added. Support for amended claim 96 and new claim 107 can be found in the specification in paragraphs 46, 48, and 96 and in Example 1. Claims 97, 105, and 106 have been amended to correct the dependencies of those claims. Claims 100 and 101 were amended to correct the numbering within those claims.

Applicant submits that no new matter has been added by the present Amendment. Applicant specifically reserves the right to pursue the subject matter of the original and previously presented claims in a related application; the present Amendment is introduced for the *sole* purpose of focusing the issues in this case and speeding its progress toward allowance. Applicant respectfully requests reexamination and reconsideration of the present case, as amended. Each of the rejections levied in the Office Action is addressed individually below.

I. Objection to the specification. The Examiner has objected to the disclosure because pages 31 and 33-35 disclose nucleic acid sequences, but do not disclose embedded sequence identifiers (*e.g.*, “SEQ ID NO:”) as required by 37 C.F.R. § 1.821(d). As requested by the Examiner, Applicant has amended the specification to include embedded sequence identifiers. Applicant, therefore, respectfully requests that the rejection be removed.

The Examiner has further objected to the disclosure because it contains an embedded hyperlink and/or other form of browser-executable code. As requested by the Examiner, Applicant has amended the specification to remove the hyperlink. Applicant, therefore, respectfully requests that the objection be removed.

The Examiner has further objected to the Drawing, and this objection is addressed in more detail below. However, the Amendment to the Drawing has necessitated Amendments to the specification. As requested by the Examiner, original Figures 2 and 4 were removed from the Drawing and are now included in the Specification as Appendices G and H, respectively. The remaining original Figures 3 and 5-12 were renumbered as Figures 2-10, so that figures remain continuously numbered. The specification was Amended to correct the numbering of figures throughout the specification.

II. Objection to the drawing. The Examiner has objected to Figures 2 and 4. In particular, the Examiner states that Figures 2 and 4 are merely text lists of viral genes or components, and that they should be moved into the specification as tables and deleted as figures. Furthermore, the Examiner states that the remaining figures should be amended so that their numbering is continuous.

As requested by the Examiner, Applicant has amended the Drawing to remove Figures 2 and 4 and renumbered the remaining figures. In addition, Applicant has amended the specification to remove the legends to Figures 2 and 4 and to renumber the legends to the remaining figures. Furthermore Applicant has amended the specification to include Appendices G and H, which correspond to original Figures 2 and 4. Finally, Applicant has amended the specification to correct all references to figure numbers. Applicant, therefore, respectfully requests that the objection be removed.

III. Rejection under 35 U.S.C. § 102(b) as being anticipated by Spitsin *et al.* (Proc. Natl. Acad. Sci., USA, 96: 2549-53, 1999). Claims 50-52, 55, 56, 59-69, 84, and 85 are rejected under 35 U.S.C. § 102(b) as being anticipated by Spitsin *et al.* (Proc. Natl. Acad. Sci., USA, 96: 2549-53, 1999). The Examiner states that Spitsin *et al.* teaches a vector in which the full-length cDNA of the RNA4 gene has been substituted into a tobacco mosaic virus vector. Thus, the Examiner states that the vector of Spitsin *et al.* anticipates the present claims. Claims 1-95 have been canceled by the present Amendment; therefore, Applicant respectfully submits that the rejection is rendered moot by the present Amendment.

IV. Rejection under 35 U.S.C. § 102(e) as being anticipated by Zhu *et al.* (U.S. Patent No. 6,858,426). Claims 50, 55, 56, 66, 68, and 86 are rejected under 35 U.S.C. § 102(e) as being anticipated by Zhu *et al.* (U.S. Patent No. 6,858,426). The Examiner states that embodiments outside of the elected species were discovered in the search for the elected species. In particular, the Examiner states that Zhu *et al.* teaches a viral vector comprising portions of several plant viruses, specifically the cauliflower mosaic virus (CaMV) 35S enhancer and promoter, the alfalfa mosaic virus RNA4 leader sequence, the Grapevine leafroll virus (type 2) coat protein gene, and the CaMV 35S 3' untranslated region. Thus, the Examiner states that the viral vector of Zhu *et al.* anticipates the present claims. Claims 1-95 have been canceled by the present Amendment; therefore, Applicant respectfully submits that the rejection is rendered moot by the present Amendment.

V. **Rejection under 35 U.S.C. § 112, first paragraph.** Claims 50-52, 55, 56, 59-69, and 82-106 are rejected under 35 U.S.C. § 112, first paragraph, as failing to comply with the written description requirement. In particular, the Examiner uses two references to suggest that “the mere presence of expressed components of a virus together is not sufficient to predict function, given any sort of change or mutation.” Thus, the Examiner argues, in the case of substituting one viral component for another, there can be no prediction of the ability of the new component to associate functionally with a second component of the original virus. The Examiner, therefore, concludes that the Applicant was not in possession of the full scope of the claimed invention at the time of filing. Applicant respectfully disagrees.

Applicant submits that the present specification demonstrates that (1) components of two different viruses (tobacco mosaic virus and alfalfa mosaic virus) are able to substitute for one another and can associate functionally with other viral components; and (2) such a system is able to successfully produce a desired protein. Furthermore, detailed methods for testing the ability of any viral components to be substituted for one another are described throughout the entire specification and are described further and demonstrated in the Examples; thus, Applicant submits that such methods are a matter of routine experimentation. Applicant reduces the invention to practice and describes methods by which any viral components can be tested for utility in accordance with the present invention. Applicant, therefore, respectfully submits that Applicant was in possession of the full scope of the claimed invention at the time of filing.

However, solely in order to further prosecution, Applicant has amended claim 96 to recite “tobacco mosaic virus” instead of “plant virus,” and has added new claim 107, which recites “alfalfa mosaic virus.” As discussed above, Applicant has clearly demonstrated that components of tobacco mosaic virus and alfalfa mosaic virus are able to substitute for one another and can associate functionally with other viral components in accordance with the present invention. Applicant, therefore, requests that this rejection be removed.

VI. **Rejection under 35 U.S.C. § 112, second paragraph.** Claims 94, 95, and 104 are rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to point out and distinctly claim the subject matter which Applicant regards as the invention. In particular, the Examiner states that there is insufficient antecedent basis for the phrase “the first and second polypeptides” in claims 94 and 95. Claims 94 and 95 are canceled by the present Amendment;

therefore, Applicant respectfully submits that the rejection is rendered moot by the present Amendment.

The Examiner further states that the phrase, "proteins of pharmaceutical interest" in claims 95 and 104 is indefinite because it is not clear what this phrase means. Thus, claim 104 has been amended to recite, "therapeutically active proteins," as stated in paragraph 61 of the specification. Applicant submits that "therapeutically active proteins" in accordance with the present invention may include any of the proteins described in paragraphs 59-66 of the specification. Applicant, therefore, respectfully requests that the rejection be removed.

Applicant therefore respectfully submits that the present case is in condition for allowance. A Notice to that effect is respectfully requested.

If, at any time, it appears that a phone discussion would be helpful, the undersigned would greatly appreciate the opportunity to discuss such issues at the Examiner's convenience. The undersigned can be contacted at (617) 248-5000.

Please charge any fees that may be required for the processing of this Response, or credit any overpayments, to our Deposit Account No. 03-1721.

Respectfully submitted,



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Date: March 12, 2007

APPENDIX A

DNA Viruses

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Circular dsDNA Viruses

◆ Family: Caulimoviridae

◆ Genus: Badnavirus

Type species: commelina yellow mottle virus

◆ Genus: Caulimovirus

Type species: cauliflower mosaic virus

◆ Genus "SbCMV-like viruses"

Type species: Soybean chlorotic mottle virus

◆ Genus "CsVMV-like viruses"

Type species: Cassava vein mosaic virus

◆ Genus "RTBV-like viruses"

Type species: Rice tungro bacilliform virus

◆ Genus: "Petunia vein clearing-like viruses"

Type species: Petunia vein clearing virus

Circular ssDNA Viruses

◆ Family: Geminiviridae

◆ Genus: Mastrevirus (Subgroup I Geminivirus)

Type species: maize streak virus

◆ Genus: Curtovirus (Subgroup II Geminivirus).

Type species: beet curly top virus

◆ Genus: Begomovirus (Subgroup III Geminivirus)

Type species: bean golden mosaic virus

RNA Viruses

ssRNA Viruses

◆ Family: Bromoviridae

◆ Genus: Alfavirus

Type species: alfalfa mosaic virus

◆ Genus: Ilarvirus

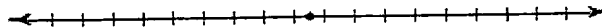
Type species: tobacco streak virus

◆ Genus: Bromovirus

Type species: brome mosaic virus

◆ Genus: Cucumovirus

Type species: cucumber mosaic virus



◆ Family: Closteroviridae

◆ Genus: Closterovirus

Type species: beet yellows virus

◆ Genus: Crinivirus

Type species: Lettuce infectious yellows virus



◆ Family: Comoviridae

◆ Genus: Comovirus

Type species: cowpea mosaic virus

◆ Genus: Fabavirus

Type species: broad bean wilt virus 1

◆ Genus: Nepovirus

Type species: tobacco ringspot virus



◆ Family: Potyviridae

◆ Genus: Potyvirus

Type species: potato virus Y

◆ Genus: Rymovirus

Type species: ryegrass mosaic virus

◆ Genus: Bymovirus

Type species: barley yellow mosaic virus



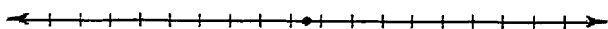
◆ Family: Sequiviridae

◆ Genus: Sequivirus

Type species: parsnip yellow fleck virus

◆ Genus: Waikavirus

Type species: rice tungro spherical virus



◆ Family: Tombusviridae

◆ Genus: Carmovirus

Type species: carnation mottle virus

◆ Genus: Dianthovirus

Type species: carnation ringspot virus

◆ Genus: Machlomovirus

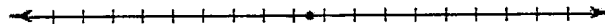
Type species: maize chlorotic mottle virus

◆ Genus: Necrovirus

Type species: tobacco necrosis virus

◆ Genus: Tombusvirus

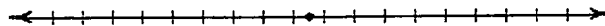
Type species: tomato bushy stunt virus



◆ Unassigned Genera of ssRNA viruses

◆ Genus: Capillovirus

Type species: apple stem grooving virus

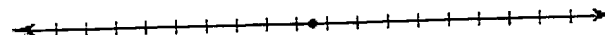


◆ Genus: Carlavirus

Type species: carnation latent virus

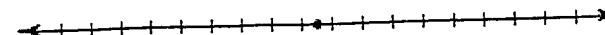
◆ Genus: Enamovirus

Type species: pea enation mosaic virus



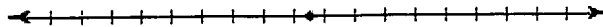
◆ Genus: Furovirus

Type species: soil-borne wheat mosaic virus



◆ Genus: Hordeivirus

Type species: barley stripe mosaic virus



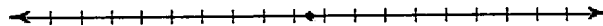
◆ Genus: Idaeovirus

Type species: raspberry bushy dwarf virus



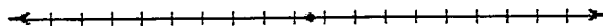
◆ Genus: Luteovirus

Type species: barley yellow dwarf virus



◆ Genus: Marafivirus

Type species: maize rayado fino virus



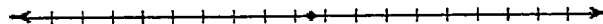
◆ Genus: Potexvirus

Type species: potato virus X



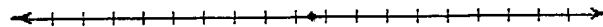
◆ Genus: Sobemovirus

Type species: Southern bean mosaic virus



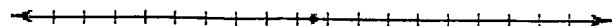
◆ Genus: Tenuivirus

Type species: rice stripe virus



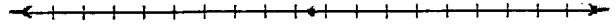
◆ Genus: Tobamovirus

Type species: tobacco mosaic virus



◆ Genus: Tobravirus

Type species: tobacco rattle virus



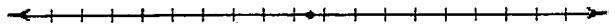
◆ Genus: Trichovirus

Type species: apple chlorotic leaf spot virus



◆ Genus: Tymovirus

Type species: turnip yellow mosaic virus



◆ Genus: Umbravirus

Type species: carrot mottle virus



Negative ssRNA Viruses

◆ Order: Mononegavirales

◆ Family: Rhabdoviridae

◆ Genus Cytorhabdovirus

Type Species lettuce necrotic yellows virus

◆ Genus: Nucleorhabdovirus

Type species: potato yellow dwarf virus



Negative ssRNA Viruses

◆ Family: Bunyaviridae

◆ Genus: Tospovirus

Type species: tomato spotted wilt virus



dsRNA Viruses


◆ Family: Partitiviridae

◆ Genus: Alphacryptovirus

Type species: white clover cryptic virus 1

◆ Genus: Betacryptovirus

Type species: white clover cryptic virus 2



◆ Family: Reoviridae

◆ Genus: Fijivirus

Type species: Fiji disease virus

◆ Genus: Phytoreovirus

Type species: wound tumor virus

◆ Genus: Oryzavirus

Type species: rice ragged stunt virus



Unassigned Viruses

◆ Genome ssDNA

- ◆ Species banana bunchy top virus
- ◆ Species coconut foliar decay virus
- ◆ Species subterranean clover stunt virus


◆ Genome dsDNA

- ◆ Species cucumber vein yellowing virus

◆ Genome dsRNA

- ◆ Species tobacco stunt virus

◆ Genome ssRNA

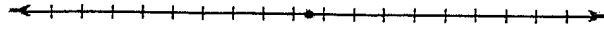
- ◆ Species Garlic viruses A,B,C,D
 - ◆ Species grapevine fleck virus
 - ◆ Species maize white line mosaic virus
 - ◆ Species olive latent virus 2
 - ◆ Species ourmia melon virus
 - ◆ Species Pelargonium zonate spot virus
- 

Satellites and Viroids

◆ Satellites

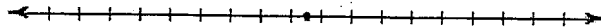
- ◆ ssRNA Satellite Viruses
 - ✦ Subgroup 2 Satellite Viruses

Type species: tobacco necrosis satellite



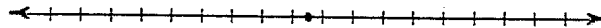
◆ Satellite RNA

- ✦ Subgroup 2 B Type mRNA Satellites
- ✦ Subgroup 3 C Type linear RNA Satellites
- ✦ Subgroup 4 D Type circular RNA Satellites



◆ Viroids

Type species: potato spindle tuber viroid



Tobamovirus Helicase

1

TMV-KR QQMSSIVYTGPIKVVQQMKNFIDSLVASLSAAVSNLVKILKDTAAIDLETR
TMV-RAK QQMSSIVYTGPIKVVQQMKNFIDSLVASLSAAVSNLVKILKDTAAIDLETR
TMV-vul QQMSSIVYTGPIKVVQQMKNFIDSLVASLSAAVSNLVKILKDTAAIDLETR
TOMV QQMCSIVYTGPLKVVQQMKNFIDSLVASLSAAVSNLVKILKDTAAIDLETR
PPMV QQMHAMVYTGPLKVVQQCKNYLDSLVAASLSAAVSNLKKIKDTAAIDLETK
TMGMV QQMASVVYTGSLKVVQQMKNYVDSLAAASLSATVSNLCKSLKDEVGYDSDSR
TMV-OB NKMASIVYSGPLQVVQQMQNYVDSLAAASLSATVSNLCKLVKDVSSVGFQDSL
ORSV KSMSSAVYTGPLKVVQQMKNYMDYLSASISATVSNLCKVLKDVYGVDPESA
TVCV GTMMSAVYTGSIKVVQQMKNYIDYLSASLAATVSNLCKVLRDVHGVDPESQ
CR-TMV GTMMSAVYTGSIKVVQQMKNYIDYLSASLSATVSNLCKVLRDVHGVDPESQ
RMV-SH GAMMSAVYTGSIKVVQQMKNYVDYLSASLSATVSNLCKVLRDVHGVDPESQ
CRMV GAMMSAVYTGSIKVVQQMKNYVDYLSASLSATVSNLCKVLRDVHGVDPESQ
TMV-CG GAMMSAVYTGSIKVVQQMKNYVDYLSASLSATVSNLCKVLRDVHGVDSSESQ
CGMMV KTITPVVYTGITIRERQMKNYIDYLSASLGSTLGNLERIVRSDWNGTEESM
CGMMV-W KTITPVVYTGITIRERQMKNYIDYLSASLGSTLGNLERIVRSDWNGTEESM
CFMMV KTITPVIYTGPIRVROMANYLDYLSANLAATIGILERIVRSNWSGN-EVV
YCGMMV KSITPVIYTGPIRVROMANYLDYLSASLTATIGNLERIVSSSWTGENELV
SHMV QKPVNIVYTGVEVQICQMNYLDYLSASLVACISNLKKYLQDQWLNPGKEF

51

TMV KR QKFGVLDVASRKWLKPTAKSHAWGVVETHARKYHVALLEYDE-QGVVTC
 TMV-RAK QKFGVLDVASRKWLKPTAKSHAWGVVETHARKYHVALLEYDE-QGIVTC
 P03586 TMV QKFGVLDVASRKWLKPTAKSHAWGVVETHARKYHVALLEYDE-QGVVTC
 TOMV QKFGVLDVASRKWLKPSAKNHAWGVVETHARKYHVALLEHDE-FGIITC
 PPMV EKFGVYDVCLKKWLKPLSKGHAWGVVMSDYKCFVALLTYDG-ENIVCG
 TMGMV EKVGVDVTLKKWLLKPAAGHSGVVDYKGMFTALLSYEG-DRMVTE
 TMV OB SKVGVDVVRKKMWLIKPTLKNHSGVVKFDGKCFALLSYHN-ELPICD
 ORSV EKSGVYDVVKGKWI IKPKDKCHAWGVADLNGEKVIVLLEWAD-GFPIC-
 TVCV EKSGVVDVRRGRWLLKPNKSHAWGVAEDANHKLVIIVLLNWDD-GKPVCD
 CR-TMV EKSGVVDVRRGRWLLKPNKSHAWGVAEDANHKLVIIVLLNWDD-GKPVCD
 RMV-SH EKSGVVDVRRGRWLLKPNKCHAWGVAEDANHKLVIIVLLNWDE-GNPVCD
 CRMV EKSGVVDVRRGRWLLKPNKCHAWGVAEDANHKLVIIVLLNWDE-GKPVCD
 TMV-CG EKSGVVDVRRGRWLLKPNKCHAWGVAEDANHKLVIIVLLNWDE-GKPVCD
 CGMMV QTFGLYDCEKCKWLLLPAAEKKHAWAVVLASDDTTRIIFLSYDESGSPIID
 CGMMV-W QTFGLYDCEKCKWLLLPAAEKKHAWAVVLASDDTTRIIFLSYDESGSPIID
 CFMMV QTYGLFDCQANKWILLPSEKTHSWGVCLTMDDKL RVLLQYDSAGWPIVD
 YCGMMV QTYGLFDCQADKWILQPTERTHSWGVCLTMDDKL RVLLQYDEFDWPVID
 SHMV QKIGVWDNLNNKWIIVVPQKKKYAWGLAADVDGNQKTIVILNYDEHGMPILE

101

TMV KR -DNWRRVAVSSESVVYSDMAKLRTLRRLLRNAGEPHVSSAKVVLVDGVP GC
 TMV-RAK -DDWRRVAVSSESVVYSDMAKLRTLRRLLRDGEPHVSSAKVVLVDGVP GC
 P03586 TMV -DDWRRVAVSSESVVYSDMAKLRTLRRLLRNAGEPHVSSAKVVLVDGVP GC
 TOMV -DNWRRVAVSSESVVYSDMAKLRTLRRLLKDGEPHVSSAKVVLVDGVP GC
 PPMV -ETWRRVAVSSESLVYSMDMGKIRAIRSVLKDGEPHISSAKVTLVDGVP GC
 TMGMV -SDWRRVAVSSDTMVYS DIAKLQNLRTMRDGEPEPTAKMVLVDGVP GC
 TMV OB -ADWSKVAVSNESMVYS DMAKLRLRKSIGEMPISVSSAKVTLVDGVP GC
 ORSV -GDWRRVAVSSDSLISYSDMGKLQTLRLCLKDGEPLRMPKVTLVDGVLGC
 TVCV -ETWFRVAVSSDSLISYSDMGKLKTLTSCSPNGEPPEPNAKVILVDGVP GC
 CR-TMV -ETWFRVAVSSDSLISYSDMGKLKTLTSCSPNGEPPEPNAKVILVDGVP GC
 RMV-SH -ETWFRVAVSSDSLISYSDMGKLKTLTACCRDGEPEPTAKVVLVDGVP GC
 CRMV -ETWFRVAVSSDSLISYSDMGKLKTLTSCCRDGEPEPTAKVVLVDGVP GC
 TMV-CG -ETWFRVAVSSDSLISYSDMGKLKTLTACCRDGEPEPTAKVVLVDGVP GC
 CGMMV KKNWKRFAVCSETKVYSVIRSLVLNKE----AIVDPGVHITLVDGVP GC
 CGMMV-W KKNWKRFAVCSETKVYSVIRSLVLNKE----AIVDPGVHITLVDGVP GC
 CFMMV KSFWKAFVCVADTKVFSVIRSLVLSAL----PLVEPDAKYVLIDGVP GC
 YCGMMV KSSWKAFVCVADTKVFSIIRSLVLSSL----PLSDPTAKFTLIDGVP GC
 SHMV -KSYVRLVVSTDTYLF TVVSMGLGYLRHL----DQKKPTATITLVDGVP GC

151

TMV KR GKTKEILSRVNFEDDLILVP(AAEMIRRRANS-SGIIIVATKDNVKTVD
 TMV-RAK GKTKEILSRVNFEDDLILVPGKQAAEMIRRRANS-SGIIIVATKDNVRTVD
 P03586 TMVGKTKEILSRVNFEDDLILVPGKQAAEMIRRRANS-SGIIIVATKDNVKTVD
 TOMV GKTKEILSRVNFEDDLILVPGRQAAEMIRRRANA-SGIIIVATKDNVRTVD
 PPMV GKTKEILSRVNFEDDLVLPVPGKQAAEMIRRRANS-SGLIVATKENVRTVD
 TMGMV GKYKGDFFRDLDEDLILVPGKQAAAMIRRRANS-SGLIRATMDNVRTVD
 TMV OB GKTKEILRRVNFSEDLVLPVPGKEAAAMIRKRAHQ-SGNIVANNDNVKTVD
 ORSV GKTKEILETVNFDEELILVPGKEACKMI IKRANK-SGHVRATKDNVRTVD
 TVCV GKTKEII EKVNFSDDLILVPGKEASKMI IRRANQ-AGVIRADKDNVRTVD
 CR-TMV GKTKEII EKVNFSDDLILVPGKEASKMI IRRANH-AGVIRADKDNVSTVD
 RMV-SH GKTKEILEKVNFSDDLVLVPGKEASKMI IRRANQ-AGVTRADKDNVRTVD
 CRMV GKTKEILEKVNFSDDLVLVPGKEASKMI IRRANQ-AGITRADKDNVRTVD
 TMV-CG GKTKEILEKVNFSDDLVLVPGKEASKMI IRRANQ-AGIIRADKDNVRTVD
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 CGMMV-W GKTAEEI IARVNWKTDLVLTTPGREAAAMIRRRACALHKS PVATNDNVRTFD
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 YCGMMV GKTQEI INSADFKTDLILTTPGKESAAMIRRRANAKFRGC VATNDNVRTFD
 SHMV GKTQEILSRFDANS DLILVQGREACEMIRRRAND-NVPGSATKENVRTFD

201

TMV KR SFMMNFGKSTRCQFKRLF IDEGLMLHTGCVNFLVMTSLCEIAYVYGD TQQ
 TMV-RAK SFMMNFGKSTRCQFKRLF IDEGLMLHTGCVNFLVAMSLCDVAYVYGD TQQ
 P03586 TMVSFMMNFGKSTRCQFKRLF IDEGLMLHTGCVNFLVAMSLCEIAYVYGD TQQ
 TOMV SFLMNYGKGARCFKRLF IDEGLMLHTGCVNFLVEMSLCDIAYVYGD TQQ
 PPMV SFLMNYGRGP-CQYKRLF DEGLMLHPGCVNFLVGMSLCSEAFVYGD TQQ
 TMGMV SLLMH---PKPRSHKRLF IDEGLMLHTGCVNFLVLISGCDIAYIYGD TQQ
 TMV OB SFLMNLGKGPVCQFKRLFVDEGLMLHPGCVYFLVKLSLCNEAFVFGD TQQ
 ORSV SFLMH---LKPKTYNKLFI DEGLMLHTGCVNFLIALSHCREAMVFGDTEQ
 TVCV SFLMH---PSRRVFKRLF IDEGLMLHTGCVNFLLLLSQCDVAYVYGD TKQ
 CR-TMV SFLMH---PSRRVFKRLF IDEGLMLHTGCVNFLLLLSQCDVAYVYGD TQQ
 RMV-SH SFLMH---PPKRVFKRLF IDEGLMLHTGCVNFLTLLSHCDVAYVYGD TQQ
 CRMV SFLMH---PPKRVFKRLF IDEGLMLHTGCVNFMLLSHCDVAYVYVD TQQ
 TMV-CG SFLMH---PPKREFKRLF IDEGLMLHTGCVNFLTLLSHCEVAYVYGD TQQ
 CGMMV SFVMN---RKIFKFDVYVDEGLMVHTGLLNFALKISGCKKAFVFGDAKQ
 CGMMV-W SFVMN---RKIFKFDVYVDEGLMVHTGLLNFALKISGCKKAFVFGDAKQ
 CFMMV SFVMN---KKPFTFKTLWVDEGLMVHTGLLNFCVNI AKVKEVRIFGD TKQ
 YCGMMV SFVMN---KKPFTFKTLWVDEGLMVHTGLLNFCVNI AKVKEVKIFGD TKQ
 SHMV SFVMN---RKPGKFKTLWVDEGLMVHPLINFCINISCVSSVYIFGDRKQ

251

TMV KR IPYINRVSGFPYP AHFAKLEVDEVETRRTTLRCPADVTHYLNRRYEGFVM
 TMV-RAK IPYINRVSGFPYP AHFSKLEVDEVETRRTTLRCPADVTHYLNRRYEGFV
 P03586 TMVIPYINRVSGFPYP AHFAKLEVDEVETRRTTLRCPADVTHYLNRRYEGFVM
 TOMV IPYINRVTFGFPYP AHFAKLEVDEVETRRTTLRCPADVTHFLNQRYEGHVM
 PPMV IPYINRVATFPYPKHLSQLEVDVETRRTTLRCPADITFFLNQKYEGQVM
 TMGMV IPFINRVQNFPPYPKHFEKLQVDEVEMRRTTLRCPGDVNFLLQSKYEGAVT
 TMV OB IPYINRVQNFPPYPQHFSKLIVDETEKRRTTLRCPVDVTHFLNQCYDGAVT
 ORSV IPFINRVANFPYPKHFGHTCLHRREVRRLSLRCPADVTHFMNSKYDGKFL
 TVCV IPFICRVANFPYP AHFAKLVADEKEVRRVTLRCPADVITYFLNKKYDGAVM
 CR-TMV IPFICRVANFPYP AHFAKLVADEKEVRRVTLRCPADVITYFLNKKYDGAVM
 RMV-SH IPFICRVANFPYP SHFAKLVDKEDRRVTLRCPADVITYFLNTRYDGSVM
 CRMV IPFICRVANFPYP AHFAKLVDKEDRRVTLRCPADVITYFLNQKYDGSVL
 TMV-CG IPFICRVANFPYPKHFAKLVDKEDRRVTLRCPADVITFFLNKKYDGAVL
 CGMMV IPFINRMNFDYPKELRTLIVDNVERRYVTHRCPRDVTSLNTIYKAAVA
 CGMMV-W IPFINRMNFDYPKELRTLIVDNVERRYVTHRCPRDVTSLNTIYKAAVA
 CFMMV IPFINRMNFDYPLELRKII VDTVEKRYTSKRCPRDVTHYLNEVYSSPVC
 YCGMMV IPFINRMNFDYPLELRKII VDDVEKRYTSKRCPRDVTHYLNEVYAAPVT
 SHMV IPFINRMNFSIPDNLAKLYYDEIVSRD'TTKRCPLDVTHFLNSVYEKRV

301

TMV KR STSSVKKS SVSQEMVGGAAVINP-ISKPLHGKILFTQSDKEALLSRGYS-
 TMV-RAK STSSVKKS SVSQEMVSGAAVINP-ISKPLHGKILFTQSDKEALLSRGYS-
 P03586 TMVSTSSVKKS SVSQEMVGGAAVINP-ISKPLHGKILFTQSDKEALLSRGYS-
 TOMV CTSSVKKS SVSQEMVSGAASINP-VSKPLKGKILFTQSDKEALLSRGYA-

```

PPMV      CTSSVTRSVSHEVIQGAAVM   VSKPLKGKIVTFTQSDKSLLSRGYE-
TMGMV     TTSTVQRSVSSEMIGGKGVLSN-VSKPLKGKIVTFTQADKFELEEKGYK-
TMV OB    TTSKTQRSVGLEVVGGAAVMNP-VTKPLKGKIVTFTQSDKLTMLSRGYQ-
ORSV      CTNDVIRSVDAEVVRGKGVFNP-KSKPLKGKIITFTQSDKAELNERGYEE
TVCV      CTSAVERSVAEVRGKGALNP-ITLPLEGKILTFTQADKFELLEKGYK-
CR-TMV    CTSAVERSVAEVRGKGALNP-ITLPLEGKILTFTQADKFELLEKGYK-
RMV-SH    CTSSVERSVAEVRGKGALNP-ITLPLEGKILTFTQADKFELLDKGYK-
CRMV      CTSSVERSVAEVRGKGALNP-ITLPLEGKILTFTQADKFELLDKGYK-
TMV-CG    CTSSVERSVAEVRGKGALNP-ITLPLEGKILTFTQADKFELLDKGYK-
CGMMV     TTSPVVHVSVAIKVSGAGILRP-ELTKIKGKIITFTQSDKQSLIKSGYN-
CGMMV-W   TTSPVVHVSVAIKVSGAGILRP-ELTKIKGKIITFTQSDKQSLIKSGYN-
CFMMV     TTSPVVHVSVTTKKIAGVGLLRP-ELTALPGKIITFTQNDKQTLKAGYA-
YCGMMV    TSSAVVHVSQKKIAGVGLLRP-ELTSLEGKIITFTQSDKQTLKAGYE-
SHMV      SYSNVQRSLECKMISGKAKINDYRSILAEGKLLTFTQEDKEYLLKAGFK-

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351

```

TMV KR     -----DVHTVHEVQGETYSDVSLVRLTPTPVSI IAGDSPHVLVALSRHTC
TMV-RAK    -----EVHTVHEVQGETYSDVSLVRLTPTPISIIAGDSPHVLVALSRHTC
P03586 TMV -----DVHTVHEVQGETYSDVSLVRLTPTPVSI IAGDSPHVLVALSRHTC
TOMV       -----DVHTVHEVQGETYADVSLVRLTPTPVSI IARDSPHVLVLSRHTK
PPMV       -----DVHTVHEVQGETFEDVSLVRLTPTPVGIISKQSPHLLVLSRHTR
TMGMV      -----NVNTVHEIQGETFEDVSLVRLTATPLTLISKSSPHVLVALTRHTK
TMV OB     -----DVNTVHEIQGETYEEVSLVRLTPTPIHII SRESPHVLVGLTRHTR
ORSV       VSTFGEINTVHEIQGETFEDVSVRLTPTALELISKSSPHVLVALTRHTK
TVCV       -----DVNTVHEVQGETYEKTAIVRLTSTPLEIISSASPHVLVALTRHTT
CR-TMV     -----DVNTVHEVQGETYEKTAIVRLTSTPLEII SRASPHVLVALTRHTT
RMV-SH     -----DVNTVHEVQGETYEKTAIVRLTATPLEII SRASPHVLVALTRHTT
CRMV       -----DVNTVHEVQGETYEKTAIVRLTATPLEII SRASPHVLVALTRHTT
TMV-CG     -----DVNTVHEVQGETYEKTAIVRLTATPLEII SRASPHVLVALTRHTT
CGMMV      -----DVNTVHEIQGETFEETAVVRATPTPIGLIARDSPHVLVALTRHTK
CGMMV-W    -----DVNTVHEIQGETFEETAVVRATPTPIGLIARDSPHVLVALTRHTK
CFMMV      -----DVNTVHEVQGETYEETS VVRATATPIGLISRKSPHVLVALSRHTK
YCGMMV     -----DVNTVHEVQGETYEECTSVVRATATPIGLISRKSPHVLVALSRHTK
SHMV       -----DVNTVHEAQGETYRDVNLI RVTATPLTIVSAGSPHVTVALSRHTN

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401

```

TMV KR     SLKYYTVVMDPLVSIIRDLEKLSSYLDDMYKVDA
TMV-RAK    SLKYYTVVMDPLVSIIRDLEKLSSYLDDMYKVDA
P03586 TMV SLKYYTVVMDPLVSIIRDLEKLSSYLDDMYKVDA
TOMV       SLKYYTVVMDPLVSIIRDLERVSSYLDDMYKVDA
PPMV       SIKYYTVVLDVAVSVLRDLECVSSYLDDMYKVDV
TMGMV      SFKYYTVVLDPLVQIISDLSSLSSFLLEMYMVEA
TMV OB     CFKYYTVVLDPLVKLVRLDLECVSNFLLDVYMVDS
ORSV       SFKYYCVVLDPLVKVCSDSLKVSDFILDMYKVDA
TVCV       CCKYYTVVLDPMVNVI SEMEKLSNFLDDMYRVEA
CR-TMV     RCKYYTVVLDPMVNVI SEMEKLSNFLDDMYRVEA
RMV-SH     RCKYYTVVLDPMVNVI SELGKLSNFLLEMYKVES
CRMV       RCKYYTVVLDPMVNVI SELGKLSNFLLEMYKVES
TMV-CG     RCKYYTVVLDPMVNVI SEMEKLSNFILD MYKVES
CGMMV      AMVYYTVVFDVTSIIADVEKVDQSILTMFATTV
CGMMV-W    AMVYYTVVFDVTSIIADVEKVDQSILTMFATTV
CFMMV      AMTYYYTVTVDPVSCIIADLEKVDQSILSMYASVA
YCGMMV     TMTYYTVTVDPVSCIIADLEKVDQSILSMYATVA
SHMV       RFVYYTVVDPDVMTTVQKTQCVSNFLDDMYAVAY

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Last Updated: Thur., May 31, 2001

Tobamovirus RNA dependent RNA polymerase

A three-dimensional structure of a RNA-dependent RNA polymerase, that encoded by poliovirus, has been reported by Hansen et al. The alignment used for tree construction is enhanced below by the amino acid sequence of the poliovirus RdRP aligned to the tobamoviral RdRp's. A 3D line is provided that identifies the helices (upper case Roman) and beta-structure elements (numerals) described in that report. The footnote line refers to notes at the bottom that relate to functional or structural comments.

```

1
TMV-vul  --MQFYFDKCLPGNSTMMNNFD--AVTMRLTDISLNVKDCILDMSKSV
TMV-Rak  --MQFYFDKCLPGNSTMMNNFD--AVTMRLTDISLNVKDCILDMSKSV
TMV-WANG --MQFYFDKCLPGNSTMMNNFD--AVTMRLTDISLNVKDCILDMSKSV
TOMV-L   --MQFYFDKCLPGNSTLLNNYD--AVTMKLTDISLNVKDCILDMSKSV
TMV-KR   --MQFYFDKCLPGNSTMMNNFD--AVTMRLTDISLNVKDCILDMSKSV
PMMV     --MQFYFDKCLPGNSTILNEYD--AVTMQIRENSLNVKDCVLDMSKSV
TMGMV    PDLQFYFDVCLPGNSTILNKYD--AVTMRLRDNSLNVKDCVLDFSKSI
ORSV     --MQFYFDKCLPGNSTILNEYD--AVTMNLRDNNLNVKDCIDFSKSV
TVCV     --MQFYFDKCLPGNSTILNEFD--AVTMNLRDISLNVKDCRIDFSKSV
CR-TMV   --MQFYFDKCLPGNSTILNEYD--AVTMNLRDISLNVKDCRIDFSKSV
RMV-SH   --MQFYFDKCLPGNSTILNEFD--AVTMNLRDISLNVKDCRIDFSKSV
CRMV     --MQFYFDKCLPGNSTILNEFD--AVTMNLRDISLNVKDCRIDFSKSV
TMV-CG   --MQFYFDKCLPGNSTILNEFD--AVTMNLRDISLNVKDCRIDFSKSV
TMV-OB   QDLQFYFDKCLPGNSTVLNEFD--AVTMNCSDISLNVKDCVLDFSKSV
CGMMV    --MQFYFDKCLPGNSFVLNDFD--AVTMRLRDNEFNLQPCRLTSLNLD
CGMMV-W  TDMQFYFDKCLPGNSFVLNDFD--AVTMRLRDNEFNLQPCRLTSLNLD
CFMMV    --MQNFYDACLPGNSFVLNDYD--SVTMRLVDNEINLQPCRLTSLKAD
YCGMMV   TDMQSFYDACLPGNSFVLNDYD--SVTMRLADNEFNLQPCRLTSLKAD
SHMV     --LQYFYDSWLPGNSFVQNNDH--QWSIISSDINLHSEAVRLDMNKRH
POLIORDR GEIQWMPRSKEVGYPINAPSKTKLEPSAFHY-VFEGVKEPAVLTKNDP
3D       -----
Footnote 11 1
TMV VUL  AP---KDQIK-PLIPMVRTAAEMPRQTGLLENLVAMIKRNFNAPELSGII
TMV-RAK  AP---KDQIK-PLIPMVRTAAEMPRQTGLLENLVAMIKRNFNAPELSGII
TMV WANG AP---KDQIK-PLIPMVRTAAEMPRQTGLLENLVAMIKRNFNAPELSGII
TOMV L   AP---KDVKP-TLIPMVRTAAEMPRQTGLLENLVAMIKRNFNSPELSGVV
TMV-KR   AP---KDQIK-PLIPMVRTAAEMPRQTGLLENLVAMIKRNFNAPELSGII
PMMV     LP---RESET-TLKPVIRTAAEKPRKPGLLENLVAMIKRNFNSPELVGVV
TMGMV SPA MP---KEVKP-CLEPVLRTAAEPRAAGLLENLVAMIKRNFNAPDLTGTI
ORSV     VP---RQQEE-FFTPVIRTAAPERPRAGLLENLVAMIKRNFNSPDLTGIL
TVCV     LP---KEQPI-FLKPKIRTAAMPRTAGLLENLVAMIKRNMNAPDLTGTI
CR-TMV   LP---KEQPI-FLKPKIRTAAMPRTAGLLENLVAMIKRNMNAPDLTGTI
RMV-SH   VP---KRPV-FMKPKLRTAAEMPRTAGLLENLVAMIKRNMNAPDLTGTI
CRMV     VP---KRPV-FMKPKLRTAAEMPRTAGLLENLVAMIKRNMNAPDLTGTI
TMV-CG   LP---RERPI-FMKPKLRTAAEMPRTAGLLENLVAMIKRNMNAPDLTGTI
TMV OB   LP---RDNTKVPMPVIRTAAPERPRAGLLENLVAMIKRNFNSPELSGTV
CGMMV    VPALIKNEAQNFLIPVLRACERPRIPGLLENLVAMIKRNMNTPDLAGTV
CGMMV-W  VPALVKSEAQNFLIPVLRACERPRIPGLLENLVAMIKRNMNTPDLAGTV
CFMMV    VTESLMEKKEFLIPLGKTATERPRIPGLLENLVAMIKRNFNTPDLAGSL
YCGMMV   VAESIKLERKNIDKLDLKTATERPRIPGFLENLVAMIKRNFNTPDLAGVL
SHMV     ----IPRTKGEFLRPLLNTAVEPPRIPGLLENLLALIKRNFNAPDLAGQL
POLIORDR L----K-TNFEEAIFSKYVGNKITEVDEHMKEAVDHYAGQLMSLDINTEQ
3D       -----AAAAAAAAAAAAAAAA-----
Footnote
TMV VUL  DIENTASLVVDKFFDSYLLKE-----KRKPNKNVSLFSRESLNRWLEKQE
TMV-RAK  DIENTASLVVDKFFDSYLLKE-----KRKPNKNVSLFSRESLNRWLEKQE
TMV WANG DIENTASLVVDKFFDSYLLKE-----KRKPNKNVSLFSRESLNRWLEKQE
TOMV L   DIENTASLVVDKFFDSYLLKE-----KRKPNKNVSLFSRESLNRWLEKQE
TMV-KR   DIENTASLVVDKFFDSYLLKE-----KRKPNKNVSLFSRESLNRWLEKQE
PMMV     DIEDTASLVVDKFFDAYLIKE-----KKKP-KNIPLLSRASLERWIEKQE
TMGMV SPA DIESTASVVVDKFFDSYFIKK-----EKYTKNIAGVMTKDSMMRWLENRK
ORSV     DIEDTAEVLVNFWDAYIIDE-LSGGNVTPM-----TSDAFHRWMAKQE
TVCV     DIEDTASLVVEKFWDSYVDKE-FSGTNEMTM-----TRESFSRWLSKQE

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CR-TMV      DIEDTASLVVEKFWDYSYIDKI   3GTNEMTM-----TRESFSRWLSKQE
RMV-SH      DIEDTASLVVEKFWDAYVVKE-FSGTDGMAM-----TRESFSRWLSKQE
CRMV        DIEDTASLVVEKFWDAYVVKE-FSGTDGMAM-----TRESFSRWLSKQE
TMV-CG      DIEDTASLVVEKFWDAYVVKE-FSGTDGMAM-----TRESFSRWLSKQE
TMV OB      DMENTASVVADRFDSYFLKDKLSGCSLGDSSGKNIIDRQALIRWMEKQE
CGMMV       DITNMSISIVDNFFSSSFVRDE-V---LLDHLDCVRASSIQSFSDWFSQCP
CGMMV-W     DITNMSISIVDNFFSSSFVRDE-V---LLDHLDCVRASSIQSFSDWFSQCP
CFMMV       DISSISKGVVDNFFSTFLRDE-Q---LADHLCKVRSLSLESFSAWFDNQS
YCGMMV      DIDTISKSVVDNFFTTFLRDE-Q---LSDHLVRVRSCSLESFSAWFHNQA
SHMV        DYDFLSRKVCDGFFGKLLPPD-VEASELLRLPVDHMYSVQNFDWLNKQE
POLIORDRP   MCLEDAMYGTGLEALDLSTS-----AGYPYVAMGKKKRDILN-----
3D          -----

```

Footnote

```

TMV VUL     QVTIGQLADFDVLDPAVDQYR-HMYKAQPKQKLDTSIQTEYPA-LQTIV
TMV-RAK     RVTIGQLADFDVLDPAVDQYR-HMIKAQPKQKLDTSIQTEYPA-LQTIV
TMV WANG    QVTIGQLADFDVLDPAVDQYR-HMIKAQPKQKLDTSIQTEYPA-LQTIV
TOMV L      QVTIGQLADFDVLDPAVDQYR-HMIKAQPKQKLDLSIQTEYPA-LQTIV
TMV-KR      QVTIGQLADFDVLDPAVDQYR-HMIKAQPKQKLDTSIQTEYPA-LQTIV
PMMV        KSTIGQLADFDVLDPAVDQYR-HMIKQPKQKLDLSIQTEYPA-LQTIV
TMGMV SPA   EVLLDDLANYNFTDLPAIDQYK-HMIKAQPKQKLDLSIQNEYPA-LQTIV
ORSV        KSTIRQLADFDVLDPAIDQYK-HMIKAQPKQKLDLSPQDEYAA-LQTIV
TVCV        SSTVGQLADFNFDVLDPAVDEYK-HMIKSQPKQKLDLSIQDEYPA-LQTIV
CR-TMV      SSTVGQLADFNFDVLDPAVDEYK-HMIKSQPKQKLDLSIQDEYPA-LQTIV
RMV-SH      SSTVGQLADFNFDVLDPAVDEYK-HMIKSQPKQKLDLSIQDEYPA-LQTIV
CRMV        SSTVGQLADFNFDVLDPAVDEYK-HMIKSQPKQKLDLSIQDEYPA-LQTIV
TMV-CG      SSTVGQLADFNFDVLDPAVDEYK-HMIKSQPKQKLDLSIQDEYPA-LQTIV
TMV OB      KSTIGQLADYDFVLDPAIDQYR-HIISQPKQKLDLSIQSEYPS-LQTIV
CGMMV       TSAVGQLANFNFDLPAFDTYM-HMIKRQPKSRLDTSIQSEYPA-LQTIV
CGMMV-W     TSAVGQLANFNFDLPAFDTYM-HMIKRQPKSRLDTSIQSEYPA-LQTIV
CFMMV       TCALGQLSNFDVLDLPPVDVYN-HMIKRQPKSKLDTSIQSEYPA-LQTIV
YCGMMV      TAAMGQLANFDFSDLPPVDMYT-HMIKRQPKSKLDTSIQSEYPA-LQTIV
SHMV        PGVVGQLANWDHIGMPAADQYR-HMIKRTPKAKLDLSIQSEYPA-LQTIV
POLIORDRP   KQTRDTKEMQKLLDITYGINLPLVITYVKDELRSKTKV-EQGSRLIEASSL
3D          -----

```

Footnote

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TMV VUL     YHSKKINAI FGPLFSELTRQLLSDVDSSRFLFFTRKTPAQIEDFFGDLDLDS
TMV-RAK     YHSKKINAI FGPLFSELTRQLLSDVDSSRFLFFTRKTPAQIEDFFGDLDLDS
TMV WANG    YHSKKINAI FGPLFSELTRQLLSDVDSSRFLFFTRKTPAQIEDFFGDLDLDS
TOMV L      YHSKKINAI FGPLFSELTRQLLSDIDSSRFLFFTRKTPAQIEDFFGDLDLDS
TMV-KR      YHSKKINAI FGPLFSELTRQLLSDVDSSRFLFFTRKTPAQIEDFFGDLDLDS
PMMV        YHSKKINALFGPVFSELTRQLLETIDSSRFMYTRKTPTQIEEFFSDLDLDS
TMGMV SPA   YHSKQINGILAG-FSELTRLLEAFDSKKFLFFTRKTPEQIEEFFSDLDLDS
ORSV        YHSKQINAI FGPLFAELTRQLLERIDSSKFLFYTRKTPEQIEEFFSDLDLDS
TVCV        YHSKKINAI FGPMFSELTRMLLERIDSSKFLFYTRKTPEQIEDFFSDLDLDS
CR-TMV      YHSKKINAI FGPMFSELTRMLLERIDSSKFLFYTRKTPEQIEDFFSDLDLDS
RMV-SH      YHSKKINAI FGPMFSELTRMLLERIDTSKFLFYTRKTPTQIEEFFSDLDLDS
CRMV        YHSKKINAI FGPMFSELTRMLLETIDTSKFLFYTRKTPTQIEEFFSDLDLDS
TMV-CG      YHSKKINAI FGPMFSELTRMLLERIDTSKFLFYTRKTPTQIEEFFSDLDLDS
TMV OB      YHSKKINALFGPIFSELTRQMLSAIDTSRYLFFTRKTPEQIEEFFSDLDA
CGMMV       YHPKVNAVFGPVFKYLTTKFLSMVDSSKFFFYTRKKPEDLQEFFSDLSS
CGMMV-W     YHPKVNAVFGPVFKYLTTKFLSMVDSSKFFFYTRKKPEDLQEFFSDLSS
CFMMV       YHSKLVNAVFGPVFRYLTFSEFLSMVDNSKFFFYTRKLRMICKFLFPHFPN
YCGMMV      YHSKLVNAVFGPVFRYLTFSEFLSMVDNSKFFFYTRKTPEDLQSFFSTLSA
SHMV        YHSKHVNAVFGPIFSCLETERLLSVVDPLRFKFFTRTPADLEFFFRDMVV
POLIORDRP   NDSVAMRMAFGNLYAAAFHK-----NPGVITGSAVGCDPDLFWSKIPV
3D          ----BBBBB-CCCCCCCC-----DDDDDD

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Footnote

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TMV VUL     HVPMDVLELDISKYDKSQNEFHCAVEYEIWRRLGFEDFLGEVWKQGHRKT
TMV-RAK     HVPMDVLELDISKYDKSQNEFHCAVEYEIWRRLGFEDFLGEVWKQGHRKT
TMV WANG    HVPMDVLELDISKYDKSQNEFHCAVEYEIWRRLGFEDFLGEVWKQGHRKT
TOMV L      HVPMDVLELDISKYDKSQNEFHCAVEYEIWRRLGLEDFLAEVWKQGHRKT
TMV-KR      HVPMDVLELDISKYDKSQNEFHCAVEYEIWRRLGFEDFLGEVWKQGHRKT
PMMV        NVPMDILELDISKYDKSQNEFHCAVEYEIWKRLGLDDFLAEVWKHGHRKT
TMGMV SPA   HVPMDVLELDISKYDKSQNEFHCAVEYEIWKRLGLNEFLAEVWKQGHRKT

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Tobamovirus RdRP--Alignment

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ORSV      TVPMEALVLDISKYDKSQNEI  AVEYFIWEKLGNGFLEEVWKQGHRKT
TVCV      TQAMEILELDISKYDKSQNEFHCAVEYKIWEKLGIDEWLAEVWKQGHRKT
CR-TMV    TQAMEILELDISKYDKSQNEFHCAVEYKIWEKLGIDEWLAEVWKQGHRKT
RMV-SH    SQAMEILELDISKYDKSQNEFHCAVEYKIWEKLGIDEWLAEVWRQGHRKT
CRMV      SQAMEILELDISKYDKSQNEFHCAVEYKIWEKLGIDDWLAEVWRQGHRKT
TMV-CG    SQAMEILELDISKYDKSQNEFHCAVEYKIWEKLGIDDWLAEVWRQGHRKT
TMV OB    HQPMEVLELDVSKYDKSQNEFHCAVEYKIWEKLGIDFLAEVWKQGHRKT
CGMMV     HSDYEILELDVSKYDKSQSDFHFSIEMAIWEKLGDDILAWMWSMGHKRT
CGMMV-W   HSDYEILELDVSKYDKSQSDFHFSIEMAIWEKLGDDILAWMWSMGHKRT
CFMMV     KQEYEILELDVSKYDKSQNDHFQAVEMLIWERLGLDDILARIWEMGHKKT
YCGMMV    KESYEILELDVSKYDKSQTDHFQAVEMLIWERLGLDDVLARIWEMGHKKT
SHMV      -GDMEILELDISKYDKSQNKHFHEVEMRIWEMLGIDKYIEKVVENGHRKT
POLIORDRP LMEEKLFAFDYTGYSASLSPAWEALEMVLEKIGFGDRVDYIDYLNHSHH
3D        D---11111111-EEEE---FFFFFFFFFFFFFF--GGGGG-----
Footnote      4      6
TMV VUL      TLKDYTAGIKTCIYQQRKSGDVTTFIGNTVIIAACLASMLPME-----K
TMV-RAK      TLKDYTAGIKTCIYQQRKSGDVTTFIGNTVIIAACLASMLRME-----K
TMV WANG     TLKDYTAGIKTCIYQQRKSGDVTTFIGNTVIIAACLASMLPME-----K
TOMV L       TLKDYTAGIKTCLWYQQRKSGDVTTFIGNTVIIASCLASMLPME-----K
TMV-KR       TLKDYTAGIKTCIYQQRKSGDVTTFIGNTVIIAACLASMLPME-----K
PMMV         TLKDYTAGIKTCLWYQQRKSGDVTTFIGNTIIIAACLSSMLPME-----R
TMGMV SPA   TLKDYIAGIKTCLWYQQRKSGDVTTFIGNTVIIAACLGSMPLPME-----K
ORSV         SLKDYTAGIKTCLWYQQRKSGDVTTFIGNTVIIAACLSMIPMD-----K
TVCV         TLKDYTAGVKTCLWYQQRKSGDVTTFIGNTIIIAACLSSMIPMD-----K
CR-TMV      TLKDYTAGIKTCLWYQQRKSGDVTTFIGNTIIIAACLSSMIPMD-----K
RMV-SH      TLKDYTAGIKTCLWYQQRKSGDVTTFIGNTIIIAACLSSMIPMD-----K
CRMV        TLKDYTAGIKTCLWYQQRKSGDVTTFIGNTIIIAACLSSMIPMD-----K
TMV-CG      TLKDYTAGIKTCLWYQQRKSGDVTTFIGNTIIIAACLSSMIPMD-----K
TMV OB      TLKDYTAGIKTCLWYQQRKSGDVTTFIGNTVIIAACMASMLPME-----K
CGMMV       ILQDFQAGIKTLIYYQQRKSGDVTTFIGNTFIIAACVASMLPLD-----K
CGMMV-W     ILQDFQAGIKTLIYYQQRKSGDVTTFIGNTFIIAACVASMLPLD-----K
CFMMV       HISDFQAGIKTLIYYQQRKSGDVTTFIGNTFIIAACVASMVPLS-----R
YCGMMV      SISDFQAGIKTVIYYQQRKSGDVTTFIGNTFIIAACVASMIPLS-----R
SHMV        HLRDYTAGIKTVIEYQQRKSGDVTTFIGNTIIIAACLCSILPME-----K
POLIORDRP   LYKNKTYCVKGGM----PSGCSGTSIFNSMINNLIIRTLLLKTYKGIDLD
3D          -----HHHHHHHHHHHHHHHHHHHHHH-----
Footnote      5      aaaaaa
TMV VUL      IIKGAFCGDDSLLYFPKGCEFPDV-QHSA--NLMWNFEAK-----LFKKQ
TMV-RAK      IIKGAFCGDDSLLYFPKGCEFPDI-QHSV--NLMWNFEAK-----LFKKQ
TMV WANG     IIKGAFCGDDSLLYFPKGCEFPDV-QHSA--NLMWNFEAK-----LFKKQ
TOMV L       LIKGAFCGDDSLLYFPKGCEYFDI-QQAA--NLMWNFEAK-----LFKKQ
TMV-KR       IIKGAFCGDDSLLYFPKGCEFPDV-QHSA--NLMWNFEAK-----LFKKQ
PMMV         LIKGAFCGDDSLIYFPKGTFDPI-QQGA--NLLWNFEAK-----LFRKR
TMGMV SPA   VIKGAFCGDDSVLYFPKGLDFDI-QSCA--NLMWNFEAK-----LYRKR
ORSV         VIKAAFCGDDSILDIPKGLDLPDI-QSEA--NLMWNFEAK-----LYRKR
TVCV         VIKAAFCGDDSLIYIPKGLDLPDI-QAGA--NLMWNFEAK-----LFRKK
CR-TMV      VIKAAFCGDDSLIYIPKGLDLPDI-QAGA--NLMWNFEAK-----LFRKK
RMV-SH      VIKAAFCGDDSLIYIPKGLDLPDI-QAGA--NLTWNFEAK-----LFRKK
CRMV        VIKAAFCGDDSLIYIPKGLDLPDI-QAGA--NLTWNFEAK-----LFRKK
TMV-CG      VIKAAFCGDDSLIYIPKGLDLPDI-QAGA--NLTWNFEAK-----LFRKK
TMV OB      VIKAAFCGDDSLVYLPKGCELPNI-QSCA--NLMWNFEAK-----LFKKT
CGMMV       CFKASFCGDDSLIYLPKGLEYDI-QATA--NLVWNFEAK-----LFRKK
CGMMV-W     CFKASFCGDDSLIYLPKGLEYDI-QATA--NLVWNFEAK-----LFRKK
CFMMV       SFKAAFCGDDSLIYMPNLEYNDI-QSTA--NLVWNFEAK-----LYKKK
YCGMMV      SFKASFCGDDSLIYMPGLEYDI-QATA--NLVWNFEAK-----LFKKR
SHMV        VFKAGFCGDDSLIYLPNLLYDI-QSVS--NNMWNFEAK-----LFKKL
POLIORDRP   HLKMIAYGDDVIASYPHEVDASLLAQSGKDYGLTMTPADKSAIFETVTWE
3D          22222---333333---IIIIIIIIIIII-4444-----
Footnote      44      9 9
TMV VUL      YGYFCGRYVIHHDRCIVYYDPLKL-ISKLGAKHIKDWEHLEEFRRSLCD
TMV-RAK      YGYFCGRYIIHHDRCIVYYDPLKL-ISKLGAKHIKDWEHLEEFRRSLCD
TMV WANG     YGYFCGRYVIHHDRCIVYYDPLKL-ISKLGAKHIKDWEHLEEFRRSLCD
TOMV L       YGYFCGRYVIHHDRCIVYYDPLKL-ISKLGAKHIKDWHEHLEEFRRSLCD
TMV-KR      YGYFCGRYVIHHDRCIVYYDPLKL-ISKLGAKHIKDWEHLEEFRRSLCD

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Tobamovirus RdRP--Alignment

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PMMV      YGYFCGRYIIHHDRCGIVVYL .KL-ISKLGAKHIKNREHLEEFRTSLCD
TMGMV SPA YGYFCGRYIIHHDKGAI VYDPLKL-ISKLGAKHIKD YDHLEELRVSLCD
ORSV      YGYFCARYIIHHDRCGAI VYDPLKL-ISKLGCKHIKSLDHLEEFRLSLCD
TVCV      YGYFCGRYVIHHDRCGAI VYDPLKL-ISKLGCKHIRDVVHLEELRESLCD
CR-TMV    YGYFCGRYVIHHDRCGAI VYDPLKL-ISKLGCKHIRDEVHLEELRRSLCD
RMV-SH    YGYFCGRYVIHHDRCGAI VYDPLKL-ISKLGCKHIRDEVHLEELRRSLCD
CRMV      YGYFCGRYVIHHDRCGAI VYDPLKL-ISKLGCKHIRDEVHLEELRRSLCD
TMV-CG    YGYFCGRYVIHHDRCGAI VYDPLKL-ISKLGCKHIRDEVHLEELRRSLCD
TMV OB    YGYFCGRYVIHHDRCGAI VYDPLKI-ISKLGAKHITDKEHLEEFRLSLAD
CGMMV     YGYFCGKYIIHHANGCIVPDPLKL-ISKLGKNSLVGYEHVEEFRLSLD
CGMMV-W   YGYFCGKYIIHHANGCIVPDPLKL-ISKLGKNSLVGYEHVEEFRLSLD
CFMMV     YGYFCGKYVIHHANGCIVPDPLKL-ISKLGKNSLESYDHLEEFRLSLMD
YCGMMV    YGYFCGKYVIHHSNGCIVPDPLKL-ISKLGKNSLESYDHLEEFRLSLMD
SHMV      HG YFCGRYILRN RYLRLLPDPLKI-ITKLGCKAIKDWDHLEEFRLSMFD
POLIORDRP NVTFLKRFFRADEKYPFLIHPVMPMKEIHESIRWTKDPRNTQDHVRSCLL
3D        -555--66666-----77777-JJJJJJJJJJ----K K K K K K K K K K K K

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Footnote      77                               88 8
TMV VUL       VAVSLNN-CAYYTQLDDAVWEVHKTAPPGSFVYKSLVKYLSDKVLFRLSLF
TMV-RAK       VAVSLNN-CAYYTQLDDAVWEVHKTAPPGSFVYKSLVKYLSDKVLFRLSLF
TMV WANG      VAVSLNN-CAYYTQLDDAVWEVHKTAPPGSFVYKSLVKYLSDKVLFRLSLF
TOMV L        VAESLNN-CAYYTQLDDAVGEVHKTAPPGSFVYKSLVKYLSDKVLFRLSLF
TMV-KR        VAVSLNN-CAYYTQLDDAVWEVHKTAPPGSFVYKSLVKYLSDKVLFRLSLF
PMMV          VAGSLNN-CAYYTHLNDAVGEVIKTAPLGSFVYRALVKYLC DKRLFQTLF
TMGMV SPA     VACSLGNWCLGFPQLNAAIKEVHKT AIDGSFAFNCVNKFLCDKFLFRTL F
ORSV          VSSSLNN-CALFGQLNDAIAEVHKTAVNGSF AFCSIIVKYLS D??????
TVCV          VASNLNN-CAYFSQLDEAVAEVHKTAVGGSFAFCSI I KYLS DKRLFRDLF
CR-TMV        VASNLNN-CAYFSQLDEAVAEVHKTAVGGSFAFCSI I KYLS DKRLFRDLF
RMV-SH        VTSNLNN-CAYFSQLDEAVAEVHKTAVGGA FVYCSI I KYLS DKRLFKDLF
CRMV          VTSNLNN-CAYFSQLDEAVAEVHKTAVGGA FVYCSI I KYLS DKRLFKDLF
TMV-CG        VTSNLNN-CAYFSQLDEAVAEVHKTAVGGA FVYCSI I KYLS DKRLFKDLF
TMV OB        VSKSLNN-CAYYAQLDEAVREVHKTAPPGSFVYKCI VKFLSNRVLFESLF
CGMMV         VAHSLFN-GAYFHLLDDAIHELFPNAGGCSFVINCLCKYLS DKRLFRSLY
CGMMV-W       VAHSLFN-GAYFHLLDDAIHELFPNAGGCSFVINCLCKYLS DKRLFRSLY
CFMMV         VAKPLFN-AAYFHLLDDAIHEYFPSVGGSTFAISSLCKYLSNKQLFGSLF
YCGMMV        VAKPLFN-AAYFHLLDDAIHEYFPSVGGSSFAINSLCKYLS DKWLFRSLF
SHMV          MACEYKN-CFGFDVLES AVKESFPKAEGCNVAFCAIYKFLSNKYLFRTL F
POLIORDRP     LAWHNGE-EEYNKFL-----AKIRSVPIGRALLLPEYSTLYRRWL
3D            KKKK--L-LLLLLLL-----LLLL--MMM-----NNNNNNNNNN

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Footnote      8                               0
TMV VUL       ID
TMV-RAK       IN
TMV WANG      ID
TOMV L        LD
TMV-KR        ID
PMMV          LE
TMGMV SPA     LN
ORSV          ??
TVCV          FV
CR-TMV        FV
RMV-SH        FV
CRMV          FV
TMV-CG        FV
TMV OB        F?
CGMMV         ID
CGMMV-W       ID
CFMMV         IK
YCGMMV        AK
SHMV          SD
POLIORDRP     DS
3D            NN
Footnote

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- Footnotes:
 - 1. N-terminal residues interacting with the thumb.
 - 4. Three aspartates involved in metal ion binding at the active site.
 - 5. Determinant of preference for NTP over dNTP. Could interact with 2' OH of substrate NTP.
 - 6. Caps a helical turn
 - 7. beta-turn.
 - 8. Interaction across interface I
 - 9. Interaction across interface I with Arg 456
 - 0. See 9.
 - a. Extra residues are present between helix H and beta-2 for poliovirus and between helix D and helix C for tobamoviruses. Their sequence similarity (YKGID for polio vs. LDSID for ToMV) suggests that they may serve similar functions in providing part of Interface I.
-

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Last Updated: 31 May 2001

Tobamovirus Movement Protein

1

SHMV SKIST--LLAPEKFKVLSVSDKFKWKAPSRVCSIVQSDTISMTANGR-SL
CGMMV SKVSVENSLKPEKFKVKSIVVDKLLPNYFSILKYLSITDFSUVKAQSYESL
CGMMV-W SKVSVENSLKPEKFKVKSIVVDKLLPNYFSILKYLSITDFSUVKAQSYESL
C-CGMMV SSVGVKNVLKPNEFKVLSVVDRLPDMFTVYRYLSVTDYSVIKSKDSECL
CFMMV SKVGVRNALKPEEFVKITWVDKLLPDAFTILKYLSITDYSVQSKDYEHL
YCGMMV SSVGVKNVLKPNEFKVLSVVDRLPDMFTVYRYLSVTDYSVIKSKDSECL
FPMV VELKEPKQLKVNDVFKMSFADKILPRSLTRLRTVSISSETNVVKLSGLGST
TMV-CG ???MSYEPKVSDFLALTKKEEILPKAFTRLKTVSISTKDVISVKDESSEL
CRMV ???MSYEPKVSDFLALTKKEEILPKALTRLKTVSISTKDVISVKESESL
CR-TMV ?MSIVSYEPKVSDFLNLSKKEEILPKALTRLKTVSISTKDIISVKESETL
RMV-SH ???MSYEPKVSDFLALTKKEEILPKALTRLKTVSISTKDVISVKESESL
TVCV ?MSIVSYEPKVSDFLNLSKKEEILPKALTRLKTVSISTKDIISVKESETL
TMGMV MAVSLRDTVKISEFIDLKQDEILPAFMTKVKSVRISTVDKIMAVKNDL
TMV-OB --MSKAIVKIDEFIKLSKSEEVLPFAFTRMKSVRVSTVDKIMAKENDNI
PMMV MALVVKDDVKISEFINLSAAEKFLPAVMTSVKTVRISKVDKVIAMENDSL
ORSV MALVLRDSIKISEFINLSASEKLLPSALTAVKSVRISKVDKIISYENDTL
TOMV-L MALVVKGVNINEFIDLKSEKLLPSMFTPVKSVMSKVDKIMVHENESL
TMV-vul MALVVKGVNINEFIDLTKMEKILPSMFTPVKSVMCSKVDKIMVHENESL
TMV-Rak MALVVKGVNINEFIDLTKMEKILPSMFTPVKSVMCSKVDKIMVHENESL

51

SHMV30K FTFDVLKDVVKHA-EEYTYVDVLGVVLSGQWLLPKGTPGSABEIIILDSRL
 CGMMV30K VPVKLLRGV--DL-TKHLYVTLLGVVSGVWNPESCRGGATVALVDTRM
 CGMMV-W VPVKLLRGV--DL-TKHLYVTLLGVVSGVWNPESCRGGATVALVDTRM
 C-CGMMV IPVDLLRGV--DL-SKSKYVTLVGVVISGVWTIPENCAGGATVALVDTRM
 CFMMV IPVDLLRGV--DF-SKSKYVTLVGVVISGVWTIPENCAGGATVALVDTRM
 YCGMMV IPVDLLRGV--DL-SKSKYVTLVGVVISGVWTIPENCAGGATVALVDTRM
 FPMV VNLNLLKGV--VLNSESKEYVTIRGVVISGVWMPPEGGGGGATVTLMDRRM
 TMVCG CDIDLLNV--PL-DKYRYVGVVLTGEWLVPDFVKGGVTVSVIDKRL
 CRMV CDIDLLNV--PL-DKYRYVGVVLTGEWLVPDFVKGGVTVSVIDKRL
 CRTMV CDIDLLNV--PL-DKYRYVGVVLTGEWLVPDFVKGGVTVSVIDKRL
 RMV-SH CDIDLLNV--PL-DKYRYVGVVLTGEWLVPDFVKGGVTVSVIDKRL
 TVCV CDIDLLNV--PL-DKYRYVGVVLTGEWLVPDFVKGGVTVSVIDKRL
 TMGMVA 30KSDVDLLKGV--KL-VKKGVCVCLVGVVSGEWNLPDNCRGGSVCIVDKRM
 TMV OB SEVDLLKGV--KL-VKKGVCVCLVGVVSGEWNLPDNCRGGSVCIVDKRM
 PMMV SDVNLLKGV--KL-VKKGVCVCLVGVVSGEWNLPDNCRGGSVCIVDKRM
 ORSV 30K SDIDLLKGV--KL-VENGVCVCLVGVVSGEWNLPDNCRGGSVCIVDKRM
 TMVL30K SEVNLLKGV--KL-IEGGVCVCLVGVVSGEWNLPDNCRGGSVCIVDKRM
 TMVOM30K SEVNLLKGV--KL-IDSGVCVCLVGVVSGEWNLPDNCRGGSVCIVDKRM
 TMV-RAK SEVNLLKGV--KL-IDSGVCVCLVGVVSGEWNLPDNCRGGSVCIVDKRM

101

SHMV30K -KGKASVLAVFNCRAATQEFQFLISPGYSLTCADALKKPFIEISCNVIDLP
 CGMMV30K HSAEGTICKFSAPATVREFSVRFIPNYSVVAADALRDPWSLFRVLSNVG
 CGMMV-W HSAEGTICKFSAPATVREFSVRFIPNYSVVAADALRDPWSLFRVLSNVG
 C-CGMMV SMVDEGTICKFSVAASRDFMVKLIIPNYYVAASDASSKPWSIFVRVSGVR
 CFMMV SLVSEGTICKFSVAASRDFMVKLIIPNYYVTAADASSKPWSLFRVSGVR
 YCGMMV SMVDEGTICKFSVAASRDFMVKLIIPNYYVLASDASSKPWSIFVRVSGVR
 FPMV KGFKNGLVAEFKTRASSRDFQFKFIPNYSMCDVDDVKRAPWELFFKLVGVP
 TMVCG ENSKECIIGTYRAAAKDRFQFKLVPNYFVSVADAKRKPQVHVRIQNLK
 CRMV ENSKECIIGTYRAAAKDRFQFKLVPNYFVSVADAKRKPQVHVRIQNLK
 CRTMV ANSKECVIGTYRAAAKDRFQFKLVPNYFVSTVADAKRKPQVHVRIQDLK
 RMV-SH ENSRESMIGTYRAAAKDRFQFKLVPNYFVSTVADAKRKPQVHVRIQDLK
 TVCV VNSKECVIGTYRAAAKDRFQFKLVPNYFVSTVADAKRKPQVHVRIQDLK
 TMGMVA 30KKRSKEATLGAYHAPACKNFSFKLIPNYSITSEDAEKHPQVVLNIRGVA
 MV OB QRHNEATLGSYTTKASKKNFSFKLIPNYSITSDAERRPWEVMVNIRGVA
 PMMV QRDDEATLGSYRTSAAKKRFAFKLIPNYSITTADAERKVVQVVLNIRGVA
 RSV 30K KRANEATLGSYHTSACKKRFTFKIIPNYSVTTADALKGIVQVMTNIRGVE
 MVL30K ERADEATLGSYTTAAKKRFAFKVVPNYGITTKDAEKNIWQVVLNIRNVK
 MVOM30K ERADEATLGSYTTAAKKRFAFKVVPNYAITTQDAMKNVWQVVLNIRNVK

TMV-RAK ERADEATLGSSYYTAAAKKRF CVVPNYAITTQDAMKNVWQVLVNIRNVK

151

SHMV30K VKDGFTPLSVEIACLVQFSNCVITRSLTMKLKE-N--PATRTF---SAEE
 CGMMV30K IKDGFHPLTLEEVACLVAATTNSIIKKGLRASVVE-SVVSSDQSI---VLDS
 CGMMV-W IKDGFHPLTLEEVACLVAATTNSIIKKGLRASVVE-SVVSSDQSI---VLDS
 C-CGMMV IKEGFSPLTLEIASLVATTNSILKKGLRVSVLE-SVVGSDASI---NLDT
 CFMMV IKDGFSPILTLEIASLVATTNSILKKGLRVSVIE-SVVGSDASV---SLDT
 YCGMMV IKEGFSPLTLEIASLVATTNSILKKGLRVSVLE-SVVGSDASI---NLDT
 FPMV IEDGYYPLAIEIATLVEQRTIINHGLRATILKRCDDISDLELPSADLDE
 TMVCG IEAGWQPLALEVSVAMVTNNVVVKGLREKVIA-VNDPNVEGF-EGVVDD
 CRMV IEAGWQPLALEVSVAMVTNNVVVKGLREKVIA-VNDPNVEGF-EGVVDD
 CRTMV IEAGWQPLALEVSVAMVTNNVVMKGLREKVVA-INDPDVEGF-EGVVDE
 RMV-SH IEAGWQPLALEVSVAMVTNNVVVKGLREKVIA-VNDPNVEGF-EGVVDD
 TVCV IEAGWQPLALEVSVAMVTNNVVMKGLREKVVA-INDPDVEGF-EGVVDE
 TMGMVA 30KMEEGYCPLSLEFVSICVHKNVNRKGLRERILS-VTDGSPIELTEKVVEE
 TMV OB MSEGWCPLSLEFVSVCIVHKNVNRKGLREKVTA-VSEDDAIELTEEVVDE
 PMMV MEKGFCPLSLEFVSVCIVHKSNIKLGLEKITS-VSEGGPVELTEAVVDE
 ORSV 30K MEKGFCPLSLEFVSICVYLNNIKLGLEKILN-VTEGGPTELTEAVVDE
 TMVL30K MSAGYCPLSLEFVSVCIVYKNNIKLGLEKVTN-VNDGGPMELSEEVVDE
 TMVOM30K MSAGFCPLSLEFVSVCIVYRNNIKLGLEKITN-VRDGGPMELTEEVVDE
 TMV-RAK MSAGFCPLSLEFVSVCIVYRNNIKIGLEKITN-VRDGGPMELTEEVVDE

201

SHMV30K VDELLGSMTTLRSIEGLRKKKEP
 CGMMV30K LSEKVEPFFDKVPISAAVMARDP
 CGMMV-W LSEKVEPFFDKVPISAAVMARDP
 C-CGMMV VSDKVQPFSDSVPITAAVIARDR
 CFMMV LSEKVPFFSDSVPITASVVSRRDR
 YCGMMV VSDKVQPFSDSVPITAAVIARDR
 FPMV SIELVSNISNIVSKRKRTHKKGKKR
 TMVCG FVDSVAAFKAVIDTFRKKKKRIGG
 CRMV FVDSVAAFKAIDSFRKKKKRIGG
 CRTMV FVDSVAAFKAVIDNFRKKKKVVEE
 RMV-SH FVDSVAAFKAIDSFRKKKKKIGG
 TVCV FVDSVAAFKAVIDNFRKKKKVVEE
 TMGMVA 30KFVDEVPMVAVKLEKVPENKKEMVG
 TMV OB FIEAVPMARRLONLKPKYNKEK
 PMMV FIESVPMADRLRKFRNQSKKGSN
 ORSV 30K FVEKVPMAARLKSFRSVNKKKPS
 TMVL30K FMENVPMVRLAKFRTKSSKRGF
 TMVOM30K FMEDVPMSIRLAKFRSRTGKKSD
 TMV-RAK FMEDVPMSIRLAKFRSRTGKKSV

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Last Updated: Thu., May 31, 2001

Alignment of tobamovirus coat protein sequences

1

TMV-OM SYSITTPSQFVFLSSAWADPIELINLCTNALGNQFQTQQARTVVQRQFSE
 S34858 SYSITTPSQFVFLSSAWADPIELINLCTNALGNQFQTQQARTVVQRQFSE
 S34857 SYSITTPSQFVFLSSAWADPIELINLCTNALGNQFQTQQARTVVQRQFSE
 S34856 SYSITTPSQFVFLSSAWADPIELINLCTNALGNQFQTQQARTVVQRQFSE
 TMV-ER SYNITTPSQFVFLSSAWADPIELINLCTNALGNQFQTQQARTVVQRQFSE
 TMV-06 SYSITTPSHFVFLSSAWADPIELINLCTNALGNQFQTQQARTVVQRQFSE
 TMV-vu1 SYSITTPSQFVFLSSAWADPIELINLCTNALGNQFQTQQARTVVQRQFSE
 TMV-DA SYSITSPSQFVFLSSVWADPIELLNVTSSLGNQFQTQQARTTVQQQFSE
 ToMV-L SYSITSPSQFVFLSSVWADPIELLNVTNSLGNQFQTQQARTTVQQQFSE
 ToMV-Kr SYTVSSANQLVYLGSVWADPIELQNLCTSLGNQFQTQQARTTVQQQFSD
 TMGMV PYTINSPSQFVYLSSAYADPVQLINLCTNALGNQFQTQQARTTVQQQFAD
 TMV-OB PYTVTSPSQLVYFGSVWADPIITFIDLCTVALGNQFQTQNARTTVQQQFSD
 PMMV AYTIVSSANQLVYLGSVWADPIELQNLCTSLGNQFQTQQARTTVQQQFSD
 PkMMV PYTVSSPNQLVYFGSVWADPIALIDLCTVSLGNQFQTQNARTTVQQQFSD
 ORSV SYTITDPSKLAYLSSAWADPNLNLCTNSLGNQFQTQQARTTVQQQFAD
 ORSV-F SYTITDPSKLAYLSSAWADPNLNLCTNSLGNQFQTQQARTTVQQQFAD
 CR-TMV SYNITNPNQYQYFAAVWAEPI PMLNQCISALSQSYQTQAARDTVRQQFSN
 TVCV SYNITNPNQYQYFAAVWAEPI PMLNQCMSALSQSYQTQAARDTVRQQFSN
 RMV SYNITNSNQYQYFAAVWAEPT PMLNQCVSALSQSYQTQAGRDTVRRQFAN
 HRMV.GER SYNITNSNQYQYFAAVWAEPT PMLNQCVSALSQSYQTQAGRDTVRRQFAN
 HRMV.JAP SYNITNSNQYQYFAAVWAEPT PMLNQCVSALSQSYQTQAGRDTVRRQFAN
 WASABI SYNITNSNQYQYFAAVWAEPIAMLNQCVSALSQSYQTQAARDTVRQQFSN
 TMV-CG SYNITSSNQYQYFAAMWAEPTAMLNQCVSALSQSYQTQAARDTVRQQFSN
 CRMV VYNITSSNQYQYFAAMWAEPTAMLNQCVSALSQSYQTQAARDTVRQQFSN
 RMV-SH VYNITSSNQYQYFAAMWAEPTAMLNQCVSALSQSYQTQAARDTVRQQFSN
 RMV-SH SYNITSSNQYQYFAAMWAEPTAMLNQCVSALSQSYQTQAARDTVRQQFSN
 RMV-CAB SYNITSSNQYQYFAAMWAEPTAMLNQCVSALSQSYQTQAARDTVRQQFSN
 CGMMV AYNPITPSKLIASFASYVPVRTLLNFLVASQGTAFQTQAGRDSFRESLSA
 CGMMV-W AYNPITPSKLIASFASYVPVRTLLNFLVASQGTAFQTQAGRDSFRESLSA
 C-CGMMV SYSTSGIRSLPAFAKSFYFPYDVYNLLVSAQGGALQTQNGKDILRESLTG
 CFMMV SYSTSGIRSLPAYTKSFYFPYFIEFYNLLVSSQGGALQTQNGKDILRDSING
 YCGMMV SYSSIFRSLPAYTKSFYFPYFIEFYNLLVSSQGGALQTQNGKDILRESLNG
 KGMMV SYSTSGIRSLPAFAKSFYFPYDVYNLLVSAQGGALQTQNGKDILRESLTG
 ZGMMV PYSTSGIRSLPAFAKSFYFPYLELYNLLITNQGAALQTQNGKDILRESLVG
 SHMV AYSIPTPSQLVYFTENYADYIPFVNRLINARSNSFQTQSGRDELREILIK

50

TMV-OM VWKPSQVTVRFDPD-SD-FKVYRYNAVLDPLVTALLGAFDTRNRIIEVEN
 S34858 VWKPSQVTVRFDPD-SD-FKVYRYNAVLDPLVTALLGAFDTRNRIIDVEN
 S34857 VWKPSQVTVRFDPD-SD-FKVYRYNAVLDPLVTALLGAFDTRNRIIDVEN
 S34856 VWKPSQVTVRFDPD-SD-FKVYRYNAVLDPLVTALLGAFDTRNRIIDVEN
 TMV-ER VWKPSQVTVRFDPD-RD-FKVYRYNAVLDPLVTALLGAFDTRNRIIEVEN
 TMV-06 VWKPSQVTVRFDPD-RD-FKVYRYNAVLDPLVTALLGAFDTRNRIIEVEN
 TMV VWKPSQVTVRFDPD-SD-FKVYRYNAVLDPLVTALLGAFDTRNRIIEVEN
 TMV-DA VWKPPQSTVRFPD-DV-YKVYRYNAVLDPLITALLGAFDTRNRIIEVEN
 ToMV-L VWKPPQSTVRFPD-DV-YKVYRYNAVLDPLITALLGAFDTRNRIIEVEN
 ToMV-KR VWKTIPTATVRFPA-TG-FKVFRYNAVLDPLVSALLGAFDTRNRIIEVEN
 TMGMV AWKPVPSMTVRFPA-SD-FYVYRYNSTLDPLITALLNSFDTRNRIIEVDN
 TMV-OB LFKTVPTRTNRFDNGENGFRVFRYNSTLDPLISALMNSFDTRNRIIEVDN
 PMMV VWKTIPTATVRFPA-TG-FKVFRYNAVLDPLVSALLGAFDTRNRIIEVEN
 PkMMV LFKTVPTRTIRFSDGENGFRVFRYNSTLDPLITALLNSFDTRNRIIETEN
 ORSV VWQPVPTLTSRFPAGAGYFRVYRYPILDPLITFLMGTFDTRNRIIEVEN
 ORSV-F VWQPVPTLASRFPAGAGYFRDYRYPILDPLITFLMGTFDTRNRIIEVEN
 CR-TMV LLSAVVAPSQRFPD-TG-SRVYVNSAVIKPLYEALMKSFDTRNRIIETEE
 TVCV LLSAVVTPSQRFPD-TG-SRVYVNSAVIKPLYEALMKSFDTRNRIIETEE
 AAB08579 LLSTIVAPNQRFDPD-TG-FRVYVNSAVIKPLYEALMKSFDTRNRIIETEE
 HRMV.GER LLSTIVAPNQRFDPD-TG-FRVYVNSAVIKPLYEALMKSFDTRNRIIETEE
 HRMV.JAP LLSTIVAPNQRFDPD-TG-FRVYVNSAVIKPLYEALMKSFDTRNRIIETEE
 WASABI LLSAIVTPNQRFPE-TG-YRVYVNSAVLKPLYEALMKSFDTRNRIIETEE


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TMV-CG      LLSAIVTPNQRFDP-TG-YRV  ISAVLKPLYESLMKSFDTNRRIETEE
CRMV        LLSAIVTPNQRFPE-AG-YRVYINSAVLKPLYESLMKSFDTNRRIETEE
RMV-SH      LLSAIVTPNQRFPE-TG-YRVYINSAVLKPLYESLMKSFDTNRRIETEE
AAD56047    LLSAIVTPNQRFPE-TG-YRMYINSAVLKPLYESLMKSFDTNRRIETEE
AAD20292    LLSAIVTPNQRFPE-SG-YRVYINSAVLKPLYEALMKSFDTNRRIETEE
CGMMV       LPSSVVDINSRFPD-AG-FYAFLNGPVLRPFI FVSLLSSTDTRNRVIEVVD
CGMMV-W     LPSSVVDINSRFPD-AG-FYAFLNGPVLRPFI FVSLLSSTDTRNRVIEVVD
C-CGMMV     LLTSVASLNSRFPA-NE-FFVWSRESRIA AAIIDSLLSALDSRNRAIEVEN
CFMMV       LLTTVASPRSRFPA-EG-FFVWSRESRIA AILDSLLSALDSRNRAIEVEN
YCGMMV      LLTSVASPKSRFPA-GE-AFVWSRESRIA AILDSLLSALDSRNRAIEVEN
KGMV        LLTSVASLNSRFPA-NE-FFVWSRESRIA AAIIDSLLSALDSRNRAIEVEN
ZGMV        LLSSVASPTSQFPS-GV-FYVWSRESRIA ALIDSLFGALDSRNRAIEVEN
SHMV        SQVSVVSPISRFPAPPA-YYIYLRDPSISTVYTALLQSTDTRNRVIEVEN

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100

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TMV-OM      QANPTTAETLDATRRVDDATVAIRSAINNLVVELIRGTGSYNRSSFESS
S34858      QANPTTAETLDATRRVDDATVAIRSAINNLVIELIRGTRSYNRSSFESSY
S34857      QANPTTAETLDATRRVDDATVAIRSAINNLVIELIRGTRSYNRSSFESS
S34856      QANPMTAETLDATRRVDDATVAIRSAINNLVIELIRGTGSYNRSSFESS
TMV-ER      QANPTTAETLDATRRVDDATVAIRSAINNLVIELIRGTGSYNRSSFESS
TMV-06      QANPTTAETLDATRRVDDATVAIRSAINNLMVELIRGTGSYNRSSFESS
TMV         QANPTTAETLDATRRVDDATVAIRSAINNLVIELIRGTGSYNRSSFESS
TMV-DA      QQSPTTAETLDATRRVDDATVAIRSAINNLVNLVRGTGLYNQNTFESMS
TOMV-L      QQSPTTAETLDATRRVDDATVAIRSAINNLVNLVRGTGLYNQNTFESMS
TOMV-KR     PQNPTTAETLDATRRVDDATVAIRASISNLMNELVRGTGMYNQALFESAS
TMGMV       QPAPNTTEIVNATQRVDDATVAIRASINNLANELVRGTGMFNQAGFETAS
TMV-OB      PANPNTSEVASATQRVDDATVNIRACINNLMNELVRGTGMMNTASFETVS
PMMV        PQNPTTAETLDATRRVDDATVAIRASISNLMNELVRGTGMYNQALFESAS
PKMMV       PANPNTAEIASATQRVDDATVSIRACINNLMNELARGTGMLNTVSFETIS
ORSV        PQNPTTTETLDATRRVDDATVAIRSAINNLLNELVRGTGMYNQVSFETIS
ORSV-F      PQNPTTTETLDATRRVDDATVAIRSAINNLLNELVRGTGMYNQVSFETMS
CR-TMV      ESRPSASEVRNATQRVDDATVSIRSQIQLLLSELSSGHGYMNRAEFEL-
TVCV        ESRPSASEVANATQRVDDATVAIRSQIQLLLSELNNGHGYMNRAEFEL-
AAB0857 9   ESRPSASEVANATQRVDDATVAIRSQIQLLLNELSNHGGYMNRAEFEL-
HRMV.GER    QSRPSASQVANATQRVDDATVAIRSQIQLLLNELSNHGGYMNRAEFEL-
HRMV.JAP    ESRPSASQVADATQRVDDATVAIRSQIQLLLNELSNHGGYMDRAQFEAI-
WASABI      ESRPSASEVANATQRVDDATVAIRSQIQLLLSELSSGHGLMNRAEFEL-
TMV-CG      ESRPSASEVANATQRVDDATVAIRSQIQLLLNELSNHGLMNRAEFEL-
CRMV        ESRPSASEVANATQRVDDATVAIRSQIQLLLNELSNHGLMNRAEFEL-
RMV-SH      ESRPSASEVANATQRVDDATVAIRSQIQLLLNELSNHGLMNRAEFEL-
AAD56047    ESRPSASEVANATQRVDDATVAIRSQIQLLLNELSNHGLMNRAEFEL-
AAD20292    ESRPSASEVANATQRVDDATVAIRSQIQLLLNELSNHGLMNRAEFEL-
CGMMV       PSNPPTTAESLNAVKRRTDDASTAARAEIDNLI ESISKGFDVYDRASFEEAF
CGMMV-W     PSNPPTTAESLNAVKRRTDDASTAARAEIDNLI ESISKGFDVYDRASFEEAF
C-CGMMV     PSNPSTGEALNATKRNDASTAAHNDIPLLLAALNDGVGVFDSASFESAF
CFMMV       PSNPSTGEALNATKRNDASTAAHNDIPLQLISALNDGAGVFDASFESQF
YCGMMV      PSNPSTGEALNATKRNDASTAAHNDIPLLLAALNDGVGVFDTASFESAF
KGMV        PSNPSTGEALNATKRNDASTAAHNDIPLLLAALNDGVGVFDSASFESAF
ZGMV        PSNPSTGEALNAVKRNDASTAAHNDIPLQLISALNEGAGVFDASFESAF
SHMV        STNVTTAEQLNAVRRRTDDASTAIHNNLEQLLSLLTNGTG VFNRTSFESAS

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150

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TMV-OM      GLVWNSGPA
S34858      GLVWTSGPA
S34857      GLVWTSGPA
S34856      GLVWTSGPA
TMV-ER      GLVWTSGPA
TMV-06      GLVWTSGPA
TMV         GLVWTSGPA
TMV-DA      GLVWTSAPA
TOMV-L      GLVWTSAPA
TOMV-KR     GLTWATTP?
TMGMV       GLVWTTTPA
TMV-OB      NLTWTTTTT

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PMMV	GLTWATTP?
PKMMV	NLTWTTAAT
ORSV	GLTWTSS??
ORSV-F	GLTWTSS??
CR-TMV	-VPWTTAAA
TVCV	-LPWTTAPA
AAB0857	-LPWTTAPA
HRMV.GER	-LPWTTAPA
HRMV.JAP	-LPWTTAPA
WASABI	-IPWATAPA
TMV-CG	-LPWTTAPA
CRMV	-LPWATAPA
RMV-SH	-LPWATAPA
AAD56047	-LPWATAPA
AAD20292	-LPWTTAPA
CGMMV	SVVWSEATT
CGMMV-W	SVVWSEATT
C-CGMMV	GLTWTASAT
CFMMV	GLVWTAASS
YCGMMV	GLTWTASSS
KGMV	GLTWTASAT
ZGMV	GLVWTAGSS
SHMV	GLTWLVTTT

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Last Updated: Thu., May 31, 2001

Tobamovirus Methyltransferase

1
 TMV-KR MAYTQTATTSALLD TVRGNN SLVNDLAKRRL YDTAVEEFNARDRRPKVNF
 TMV-Rak MAYTQTATTSALLD TVRGNN SLVNDLAKRRL YDTAVEEFNARDRRPKVNF
 TMV-vul MAYTQTATTSALLD TVRGNN SLVNDLAKRRL YDTAVEEFNARDRRPKVNF
 TOMV MAYTQTATSSALLE TVRGNN TLVNDLAKRRL YDTAVEEFNARDRRPKVNF
 PMMV MAYTQOATNAALAST LRGN NPLVNDLANRRL YESAVEQCNAHRRPKVNF
 TMGMV MAHIQSI IISNALLE SVSGKNTLVNDLARRRMYDTAVEEFNARDRRPKVNF
 TMV-OB MAHIQQSMOGALLD TVRGQNSLVNDLAKRRL YDTAVEEFNAKDRRPKINF
 ORSV MAHFQQTMTNTKVTEAG IGRNSLINDLAQRRVYDKPVEELNHRSSRPKVNF
 TVCV MAQFQQTIDMQTLQAAAGRN SLVNDLASRRVYD NAVEELNARSRRPKVHF
 CR-TMV MAQFQQTIDMQTLQAAAGPN SLVNDLASRRVYD NAVEELNARSRRPKVHF
 RMV-SH MAQFQQTVMNQTLQAAAGRN SLVNDLASRRVYD NAVEELNARSRRPKVHF
 CRMV MAQFQQTVMNQTLQAAAGRN SLVNDLASRRVYD NAVEELNARSRRPKVHF
 TMV-CG MAQFQQTVMNQTLQAAAGRN SLVNDLASRRVYD NAVEELNARSRRPKVHF
 CGMMV MANINEQINNQRDAAASGRNN LVSQLASKRVYDEAVRSLDHQDRRPKMNF
 CGMMV-W MANINEQINNQRDAAASGRNN LVSHLASKRVYDEAVRSLDHQDRRPKMNF
 CFMMV MANITQHINDTREAAAAGRN PLVAQLASKRVYDEAVKSLDSQDKRPKVNF
 YCGMMV MANITQOI IDTREAAAAGRN PLIAQLASKRVYDEAVKSLDTQDKRPKVNF
 SHMV ---MSTSTL INKAQTNSCGDVGVDLLKRVYDDTVKTMQGLDRRAKYRL

51
 TMV-KR SKVISEEQTLIATRAYPEFQITFYNTQNAVHSLAGGLRSLELEYLMMQIP
 TMV-RAK SKVISEEQTLIATRAYPEFQITFYNTQNAVHSLAGGLRSLELEYLMMQIP
 TMV SKVISEEQTLIATRAYPEFQITFYNTQNAVHSLAGGLRSLELEYLMMQIP
 TOMV SKVVSEEQTLIATKAYPEFQITFYNTQNAVHSLAGGLRSLELEYLMMQIP
 PPMV LRSISEEQTLIATKAYPEFQITFYNTQNAVHSLAGGLRSLELEYLMMQIP
 TMGMV SKTISEEQTLIVSNAYPEFQITFYNTQNAVHSLAGGLRALELEYLMLQVP
 TMV-OB SKSINEEQTLIVSQAYPEFQITFYNTQLAVHSLAAGLRSLELEYLMMQVP
 ORSV SKVISQEII IQATNAYAEFEITFYNTQLAVHSMAGGLRALELEYRRMQIP
 TVCV SKAVSTEQTLIATNAYPEFEISFTHTQSAVHSLAGGLRSLELEYLMMQVP
 CR-TMV SKAVSTEQTLIATNAYPEFEISFTHTQSAVHSLAGGFRLSLELEYLMMQVP
 RMV-SH SKSVSTEQTLIASNAYPEFEISFTHTQHAVHSLAGGLRTLELEYLMMQVP
 CRMV SKSVSTEQTLIASNAYPEFEISFTHTQQA VHS LAGGLRTLELEYLMMQVP
 TMV-CG SKSVSTEQTLIASNAYPEFEISFTHTQQA VHS LAGGLRTLELEYLMMQVP
 CGMMV SRVVSTEHTRLVTDAYPEFSISFTATKNSVHSLAGGLRLLELEYMMM QVP
 CGMMV-W SRVVSTEHTRLVTDAYPEFSISFTATKNSVHSLAGGLRLLELEYMMM QVP
 CFMMV ARVLTTEQTRKVTESYPEFSISYTSALSVHSLAGGLRYLEGEYLM MQVP
 YCGMMV SRVLSTEQMRVVTENYPEFSVS YTG SALS VHSLAGGLRYLEGEYLM MQVP
 SHMV NQCLGPEQCR TVRGGYPEFQIEFTGASNTSHAMAAGLRGLELEYLYTLVP

101
 TMV-KR YGSLTYDIGGNFASHLFKGRAYVHCCMPNLDVRDIMRHEGQKDSIELYLS
 TMV-RAK YGSLTYDIGGNFASHLFKGRAYVHCCMPNLDVRDIMRHEGQKDSIEL ---
 TMV YGSLTYDIGGNFASHLFKGRAYVHCCMPNLDVRDIMRHEGQKDSIELYLS
 TOMV YGSLTYDIGGNFASHLFKGRAYVHCCMPNLDVRDIMRHEGQKDSIELYLS
 PPMV YGSTTYDIGGNFAAHMFKGRDYVHCCMPNMDLRDVMRHNAQKDSIELYLS
 TMGMV YGSPTYDIGGNFAAHLFKGRDYVHCCMPNLDIRDIMRHEGQKDSIEMYLS
 TMV-OB YGSLTYDIGGNFAAHLFKGRDYVHCCMPNLDLRDIMRHENQKDSVATYLS
 ORSV FGSITYDIAGNFSAHIYKGRDYVHSCMRNLDIRDVARHINQQDTVSSYVA
 TVCV FGSITYDIGGNFSAHLFKGRDYVHCCMPNLDVRDIARHEGHKEAIIYSYVN
 CR-TMV FGSITYDIGGNFSAHLFKGRDYVHCCMPNLDVRDIARHEGHKEAIIHSYVN
 RMV-SH FGSITYDIGGNFAAHLFKGRDYVHCCMPNLDVRDIARHEGHKEAIFS YLS
 CRMV FGSITYDIGGNFAAHLFKGRDYVHCCMPNLDVRDIARHEGHKEAIFS YLS
 TMV-CG FGSITYDIGGNFAAHLFKGRDYVHCCMPNLDVRDIARHEGHKEAIFS YIS
 CGMMV YGSPCYDIGGNYTQHLFKGRSYVHCCNPCLDLKDVARNVMYNDMITQHVQ
 CGMMV-W YGSPCYDIGGNYTQHLFKGRSYVHCCNPCLDLKDVARNVMYNDVVTQHVQ
 CFMMV YGSPVYDIGGNYSQHMLKGRAYVHCCNPCLDLKDVARNEMYKDAIDRYVH
 YCGMMV YGSPCHYIGGNYSQHMLKGRSYVHCCNPCLDLKDVARNEMYKDAIER YVT
 SHMV YGAVSYDIGGNFPAHMMKGRSYVHCCNPALDARDLARNENYRISIENYLS

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TMV-KR      RL-----ERG'   KTVPNFQKEAFDRYAELPEDAVCHNTF
TMV-RAK     -L-----DRG6--KTVPNFQKEAFDRYAELPEDAVCHNTF
TMV         RL-----ERGG--KTVPNFQKEAFDRYAELPEDAVCHNTF
TOMV        RL-----ERGN--KHVPNFQKEAFDRYAEMPNEVVCHDTF
PPMV        KL-----AQKK--KVIPPYQKPCFDKYTDDPQSVVCSKPF
TMGMV       RL-----SRSN--KVIPEFQREAFNRYAEAPNEVCCSKTF
TMV-OB      RL-----KARN--KVLPAFQQAFAFQRYSERSEVVCNNTF
ORSV        RL-----ERSK--RGLPVFQQAFAFNKYMSDPAVCSDKRF
TVCV        RL-----KRQQ--RPVPEYQRAAFNRYAENPHFVHCDKPF
CR-TMV      RL-----KRQQ--RPVPEYQRAAFNRYAENPHFVHCDKPF
RMV-SH      RL-----DRQK--RPVPEYQRAAFNRYAENPHFVHCDRPF
CRMV        RL-----DRQR--RPVPEYQRAAFNRYAENPHFVHCDRPF
TMV-CG      RL-----DRQR--RPVPEYQRAAFNRYAENPHFVHCDRPF
CGMMV       RH-----KGSGCRPLPTFQIDAFRRYDSSPCAVTCSDFV
CGMMV-W     RH-----KGSGGRPLPTFQIDAFRRYDSSPCAVTCSDFV
CFMMV       KKREAPRSNAWRARAESVQEIKDGRLPWQIDAFQRYKDCPRAVTCNDVF
YCGMMV      KKRDGPRSVAWRSQAESSQETKFAGLPWQMDAFRRYHSDPSSVTCPDVF
SHMV        RFEDKSGDYCQWQR---KKPKVSKPLPRYQKACFDRYNEDPEHVTCSETF

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201

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TMV-KR      QTMRHQPMQQSGRVYAIALHSIYDIPADEFGAALLRKNVHTCYAAFHFSE
TMV-RAK     QTCEHQPMQQSGKVYAIALHSIYDIPADEFGAALLRKNVHTCYAAFHFSE
TMV         QTMRHQPMQQSGRVYAIALHSIYDIPADEFGAALLRKNVHTCYAAFHFSE
TOMV        QTCRHSQECYTGRVYAIALHSIYDIPADEFGAALLRKNVHVCYAAFHFSE
PPMV        QHCEGV-SHCTDKVYAVALHSLYDIPADEFGAALLRRNVHVCYAAFHFSE
TMGMV       QDCRIHPPENSGRRYAVALHSLYDIPVHEFGAALISKNIHV CYAASILAE
TMV-OB      QCCESNRYSSGGRVYAISLHSLYDIPADELGAALLRKNVHTLYAAFHFAE
ORSV        QECSYS-VDLPGKTYAVGLHSIYDIPADEFGAALLRKDVHICYAAFHISE
TVCV        QQCELT-TAYGTDTYAVALHSIYDIPVEEFGSALLRKNVKT CFAAFHFHE
CR-TMV      QQCELT-TANGTDTYAVALLSIYDIPVEEFGSALLRKNVKT CFAAFHFHE
RMV-SH      QQCEIS-TVNGADTYAIALHSIYDIPADEFGAALLRKNVKICYAAFHFHE
CRMV        QQCELS-TVNRWDTYAIALHSIYDIPADEFGAALLRKNVKICYAAFHFHE
TMV-CG      QQCKLS-AANGADTYAIALHSIYDIPVDEFGAALLRKNVKICYAAFHFHE
CGMMV       QECSDY-FGSGRDNHAVSLHSIYDIPYSSIGPALHRKNVRVCYAAFHFSE
CGMMV-W     QECSDY-SGSGGDNHAVSLHSIYDIPYSSIGPALHRKNVRVCYAAFHFSE
CFMMV       QECQYE-HTRRGDRYAVALHSIYDIPFEQIGPALLRKNIKVLFAAFHFSE
YCGMMV      QQCEHE-FSRGGDRYAVALHSIYDVPCEQIGPALLRKNIKVLFAAFHFSE
SHMV        EKCRISPPAERDDIYATSLHSLYDIPYQNLGPALARKRIKVLHAAFHFSE

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251

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TMV-KR      NLLLED SYVNLDEINACFSRDGDKLTFSFAESTLNYCHSYSNILKYVCK
TMV-RAK     NLLLED SYVNLDEINACFSRDGDKLTFSFAESTLNYCHSFSNILKYVCK
TMV         NLLLED SYVNLDEINACFSRDGDKLTFSFAESTLNYCHSYSNILKYVCK
TOMV        NLLLED SHVNLDEINACFQRDGDRLTFSFAESTLNYSHSYSNILKYVCK
PPMV        NLLLED SYVSLDDIGAFFSREGDMLNFSFVAESTLNYTHSYSNVLKYVCK
TMGMV       ALLLDQTEVTLNEIGATFKREGDDVSFFFAESTLNYSHKYKNILHYVVK
TMV-OB      ELLLEVSTVELPTIGGIFSRDGDKINFCFSNESTLNYSHSYSNLLKYVCK
ORSV        NLLLETTSAPLDEIGATKYKSGDRLSFFIQNESTLNYEHSYKNVIKYVCK
TVCV        NMLLDCDVTTLDEIGATFQKSGDNLSFFFHNESTLNYTHSFSNIIKYVCK
CR-TMV      NMLLDCDVTTLDEIGATFQKSGDNLSFFFHNESTLNYTHSFSNIIKYVCK
RMV-SH      NMLLDCDSVTLEDIGATFQKSGDNLSFFFHNESTLNYTHSFSNIIKYVCK
CRMV        NMLLDCDSVTLEDIGATFQKSGDNLSFFFHNESTLNYTHSFSNIIKYVCK
TMV-CG      NMLLDCDSVTLEDIGATFQKSGDNLSFFFHNESTLNYTHSFSNIIKYVCK
CGMMV       ALLLGSPVGNLNSIGAQFRVDGDDVHFLFSEESTLHYTHSLENIKLIVMR
CGMMV-W     ALLLGSPVGNLNSIGAQFRVDGDDVHFLFSEESTLHYTHSLENIKLIVMR
CFMMV       ELLLGQSFGALPNIGAFFTVNGDSVEFQFEEESTLHYSHSFQNIKIVTR
YCGMMV      DLLLIGSEFGRLPNVGAFFSVDGDSVNFQFEDESTLHYTHSFSNIRKIVTR
SHMV        DLLLGASEGLLTQIGGTFQKSGDNLSFFFLDESSLIYTHSFRNVFEYVTR

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301

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TMV-KR      TYFPASNREVYMKFLVTRVNTWFCKFSRIDTFLLYKGV AHKSVDSEQFY
TMV-RAK     TYFPASNREVYMKFLVTRVNTWFCKFSRIDTFLLYKGV AHKSVDSEQFY
TMV         TYFPASNREVYMKFLVTRVNTWFCKFSRIDTFLLYKGV AHKSVDSEQFY
TOMV        TYFPASNREVYMKFLVTRVNTWFCKFSRIDTFLLYKGV AHKSVDSEQFY

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PPMV      TYFPASSREVYMKFELVTRV FCKFSRLDTFVLYRGVYHRGVDKEQFY
TMGMV     SYFPASSRIVYFKEFLVTRVN WFKFKTKVDTYILYKSVRQVGCDSDQFY
TMV-OB    TYFPASNRFVYHKEFMCTRVNTWFKFKTKVDTYFLFRGVYTRGEDSEQFY
ORSV      TFIPASNRFVYHKEFMCTRVNTWFKFKTKVDTYFLFRGVYTRGEDSEQFY
TVCV      TFFPASQRFVYHKEFLVTRVNTWYCKFTRVDTFTLFRGVYHNNVDCEEFY
CR-TMV    TFFPASQRFVYHKEFLVTRVNTWYCKFTRVDTFTLFRGVYHNNVDCEEFY
RMV-SH    TFFPASQRYVYHKEFLVTRVNTWYCKFTRVDTFTLFRGVYRTSVDSEEFY
CRMV      TFFPASQRYVYHKEFLVTRVNTWYCKFTRVDTFTLFRGVYKTSVDSEEFY
TMV-CG    TFFPASQRYVYHKEFLVTRVNTWYCKFTRVDTFTLFRGVYRSSVDSEEFY
CGMMV     TYFPADDRFVYIKEFMVKRVD TFFRLVRADTHMLHKS VGHYS-KS----
CGMMV-W   TYFPADDRFVYIKEFMVKRVD TFFRLVRADTHMLHKS VGHYS-KS----
CFMMV     TYFPASDRVVYVKEFMVKRVD TFFRMVRVDTHMLHKS VGTYP-VC----
YCGMMV    TFFPASDRVVYVKEFMVKRVD TFFRMVRVDTHMLHKS VGYQYQ-VS----
SHMV      TFFVACNRYAYMKEFRSRRVD TVFCSFIRIDTYCLYRSVFKDC-DEHV-F

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351

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TMV-KR    TAMEDAWHYKKT LAMCNSERILLEDSSSVNYWFPKMRDMVIVPLFDISLE
TMV-RAK   TAMEDAWHYKKT LAMCNSERILLEDSSSVNYWFPKMRDMV I I PLFDISL-
TMV       TAMEDAWHYKKT LAMCNSERILLEDSSSVNYWFPKMRDMVIVPLFDISLE
TOMV      KAMEDAWHYKKT LAMCNSERILLEDSSSVNYWFPKMRDMVIVPLFDISLE
PPMV      SAMEDAWHYKKT LAMNNSERILLEDSSSVNYWFPKMKDMVIVPLFDVSLQ
TMGMV     EAMEDAFAYKKT LAMFNTERAIFRDTASVNFWFPMKDMVIVPLFEGSIT
TMV-OB    SAMEDAWHYKKT LAMLNSERIVLEDHSSSVNYWFPKMKDMVIVPLFDVSLQ
ORSV      TAMDEAWEYKKT LAMLNSERTIFRDRAAVNFRFPKV KDMVIVPLFDGSVT
TVCV      KAMDDAWHYKKT LAMLNAERTIFKD NAALNFWFPKVRDMVIVPLFDASIT
CR-TMV    KAMDDAWHYKKT LAMLNAERTIFKD NAALNFWFPKVRDMVIVPLFDASIT
RMV-SH    KAMDDAWEYKKT LAMLNSERTIFKDS AAMNFWFPKVRDMV I I PLFDASIT
CRMV      KAMDDAWEYKKT LAMLNSERTIFKDS AAINFWFPKVRDMV I I PLFDASIT
TMV-CG    KAMDDAWEYKKT LAMLNSERTIFKDS AAMNFWFPKVRDMV I I PLFDASIT
CGMMV     -----KSEYFALNTPPIFQDKATFSVWFPEAK-KVLIPKFELSRF
CGMMV-W   -----KSEYFALNTPPIFQDKATFSVWFPEAKRKVLI PKFELSRF
CFMMV     -----ATNYFSLKSSPIFQDKATFSVWFPAKSKVVIPIFKMQGF
YCGMMV    -----KNDYYSLKSSPVFQDKATFSVWFPAKSKVVIPLFEMQGF
SHMV      AAMDDAWEFKKRVMLEASRPIFNDVAQFNVPNAKDKVCLPIFAVKSV

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401

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TMV-KR    TSKR--TRKEVLVSKDFVFTVLNHIRTYQAKALTYANVLSFVESIRSRVI
TMV-RAK   -----SRKEVLVSKDFVFTVLNHIRTYQAKALTYANVLSFVESIRSRVI
TMV       TSKR--TRKEVLVSKDFVFTVLNHIRTYQAKALTYANVLSFVESIRSRVI
TOMV      TSKR--TRKEVLVSKDFVFTVLNHIRTYQAKALTYSNVLSFVESIRSRVI
PPMV      NEGKRLARKEVMVSKDFVFTVLNHIRTYQSKALTYANVLSFVESIRSRVI
TMGMV     SKKM--TRSEVIVNRDFVFTVLNHIRTYQAKALTYQNVLSFVESIRSRVI
TMV-OB    TQKR--TKKEVIVSKDFVFTVLNHIRTYQAKALTYNNVLSFVESIRSRVI
ORSV      SGKM--KRREVMVNKDFVFTVLNHIRTYQDKALTYKNVLSFVESIRSRVI
TVCV      TGRM--SRREIMVNKDFVFTVLNHIKTYQAKALTYANVLSFVESIRSRVI
CR-TMV    TGRM--SRREVMVNKDFVFTVLNHIKTYQAKALTYANVLSFVESIRSRVI
RMV-SH    TGRM--SRREVLVNKDFVFTVLNHIKTYQAKALTYANVLSFVESIRSRVI
CRMV      TGRM--SRREVLVNKDFVFTVLNHIKTYQAKALTYANVLSFVESIRSRVI
TMV-CG    TGRM--SRREVLVNKDFVFTVLNHIKTYQAKALTYANVLSFVESIRSRVI
CGMMV     LSGNVKISR-MLVDADFVHTIINHISTYDNKALVWKNVQSFVESIRSRVI
CGMMV-W   LSGNVKISR-MLVDADFVHTIINHISTYDNKALVWKNVQSFVESIRSRVI
CFMMV     FTGSIVA EK-MMIDASFIHTVINHICTYDNKALTWRNVQSFVESIRSRV
YCGMMV    FSGTLKSKK-MLVDATFIHTVINHICTYDNKALTWRNVQSFVESF-GLGC
SHMV      SGAPVTTRH-ILVEKDFYWTALNHILTYPDGKADFRGVMSFLESIRSRV

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451

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TMV-KR    INGV TARSEWDVDKSL LQSLSM TFFYLHTKLAVLKDDLLISKFSLGSKTVC
TMV-RAK   INGV TARSEWDVDKSL LQSLSM TFFLHTKLAVLKDDLLISKFSLGSKTVC
TMV       INGV TARSEWDVDKSL LQSLSM TFFYLHTKLAVLKDDLLISKFSLGSKTVC
TOMV      INGV TARSEWDVDKSL LQSLSM TFFLHTKLAVLKDDLLISKFALGPKTVS
PPMV      INGV TARSEWDVDKALLQSLSM TFFLQTKLAMLKDDL VVQKFQVHSLT
TMGMV     INGV TARSEWDVDKAILQPLSM TFFLQTKL AALQDDIVMGKFRCLDKTTS
TMV-OB    INGV TARSEWDVDKALLQSMAM TFFLITKLSMLKDELLVSKFTLSAKSVH
ORSV      MNGV TARSEWEVDKSVLQPLSM TFFLQTKLAEAKDQVVLKFKQKIDT V T

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TVCV      INGVTARSEWDTDKAILGPL FFLITKLGHVQDEIILKKFQKFDRTTN
CR - TMV   INGVTARSEWDTDKAILGPLAM FFLITKLGHVQDEIILKKFQKFDRTTN
RMV - SH   INGVTARSEWDTDKAILGPLAMTFFLVTKLSHVQDEIVLKKFQKFDATAK
CRMV       INGVTARSEWDTDKAILGPLAMTFFLVTKLSHVQDEIVLKKFQKFDATAK
TMV - CG   INGVTARSEWDTDKAILGPLAMTFFLVTKLSHVQDEIVLKKFQKFDATTK
CGMMV      VNGVSVKSEWNVPVDQLTDISFSIFPLVKVRKVQIELMSDKVVI EARGLL
CGMMV - W  VNGVSVKSEWNVPVDQLTDISFSIFLLVKVRKVQIELMSDKVVI EARGLL
CFMMV      VNGVSVRSEWDVPVELLTDISFTVFLLVKVKKTQIEIMSDKIVTQPQGLI
YCGMMV     MNGVSVRSEWDVPIEMLCDISFTVFLTVKV -KVQIEIMSEKIVTQPQGLL
SHMV       INGTTTASQWEVDKSQLKDIALSLLLI AKLEKLKISVIEKRIKIERQGLV

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501

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TMV - KR   QHVWDEISLAFGNAPPSVKERLLNRKLIRVAGDALEIRVPDLYVTFHDRL
TMV - RAK  QHVWDEISLAFGNAPPSVKERLLNKKLIRAAGDALEIKVPDLYITFHDRL
TMV        QHVWDEISLAFGNAPPSVKERLLNRKLIRVAGDALEIRVPDLYVTFHDRL
TOMV       QHVWDEISLAFGNAPPSIKERLINRKLIKITENALEIRVPDLYVTFHDRL
PPMV       EYVWDEITAAFHNCFTPIKERLINKKLITVSEKALEIKVPDLYVTFHDRL
TMGMV      ELIWDEVGKFFGNVFTPIKERLVSRKILDVSENALKIKIPDLYVTWKDRF
TMV - OB   EHVWDEIKRGCNMFPSLKESLLRKKLISGSAEELEIEVPDMYVTFHDFR
ORSV       NLFWKQISDAVGDLFPSIKERLISGGFVKVAEQSLQIKTPDEYITFADKL
TVCV       ELIWTSLCDALMGVIPSVKETLVRGGFVKVAEQALEIKVPELYCTFADRL
CR - TMV   ELIWTSLCDALMGVIPSVKETLVRGGFVKVAEQALEIKIPELYCTFADRL
RMV - SH   ELIWSSLCDALKGVIPSVKETLARGGFVKLAESLEIKIPELYCTFTDRL
CRMV       ELIWSSLCDALKGVIPSVKETLARGGFVKLAESLEIKIPELYCTFTDRL
TMV - CG   ELIWTSLCDALKGVIPSVKETLARGGFVKLAESLEIKIPELYCTFTDRL
CGMMV      RRFADSLKSAVEGLGDCVYDALVQTGWFDTSDELKVLLPEPFMTFSDYL
CGMMV - W  RRFADSLKSAVEGLGDCVYDALVQTGWFDTSDELKVLLPEPFMTFSDYL
CFMMV      ERIVQVRSEAFEGCTEAVQKALLTSGWFRTPADDLVLDIPELFMDFHDYL
YCGMMV     LRLAQKVSDAFEGCTATIHAALMSTGWFRCADELVEAPELFMDFHDHFL
SHMV       SLLKEFLHGLLDEYTQMAEWVVEKGVKSVDQVLQVTIPDLVLNFRDHF

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551

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TMV - KR   VTEYKASVDMPALDIRKKMEE -- TEVMYNALSEL SVLRESDKFDVDVFSQ
TMV - RAK  VAEYKSSVDMPALDIRKKMEE -- TEVMYNALSEL SVLRESDKFDVDVFSQ
TMV        VTEYKASVDMPALDIRKKMEE -- TEVMYNALSEL SVLRESDKFDVDVFSQ
TOMV       VSEYKMSVDMPVLDIRKKMEE -- TEEMYNALSEL SVLKNSDKFDVDVFSQ
PPMV       VKEYKSSVEMPVLDVKKSL EE -- AEVMYNALSEI SILKDSKFDVDVFSR
TMGMV      VAEYTKSEELPHLDIKDLEE -- AEQMYDALSEL SILKGADNFDIAKFKD
TMV - OB   VAEYKASVEMPTIDISKDLSE -- AESYYSALSEL SVLENSKFDLEKFSR
ORSV       VMEYKATEELQHLDISKPLER -- AEKYYNALSEL SVLKEDEFDITQFKN
TVCV       VLQYKKAEEFQSCDLSKPLEE -- SEKYYNALSEL SVLENLDSFDLEAFKT
CR - TMV   VLQYKKAEEFQSCDLSKPLEE -- SEKYYNALSEL SVLENLDSFDLEAFKT
RMV - SH   VLEYKRTEEFQSCDLSKPLEE -- SEKYYNALSEL SVLENLDSFDLDAFKE
CRMV       VLEYKRTEEFQSCDLSKPLEE -- SEKYYNALSEL SVLENLGSFDLDAFKE
TMV - CG   VLQYKMAEEFKSCDLSKPLEE -- SEKYYNALSEL SVLENLDSFDLDGFKE
CGMMV      EGMYEADAKIERESVSELLAS -- GDDLFFKKIDEIRNNYSGVEFDVEKFQE
CGMMV - W  EGTYEADAKIERESVSELLAS -- GDDLFFKKIDEIRNNYSGVEFDVEKFQE
CFMMV      SGVFESRMLVLRRTVEKCFKRFP T SFIRLYRKL CERYSGIEFDLEQVSD
YCGMMV     SAAWEADAKIEAANVESV LDA -- SDRLYTTVNELCERYSGIEFDLEKFTD
SHMV       RCEFRTSANVSENVSEHLVA -- TNEYAKVSDLVDRNPTLAFDFEKFQD

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TMV - KR   MCQSLEVDPM TAAKVIVAVMSNESGLTLT FERPT EANVALALQDQ - EKAS
TMV - RAK  MCKSLEVDPM TAAKVIVAVMSNESGLTLT FERPT EANVAQALQDQ - EKAS
TMV        MCQSLEVDPM TAAKVIVAVMSNESGLTLT FERPT EANVALALQDQ - EKAS
TOMV       MCQSLEVDPM TAAKVIVAVMSNESGLTLT FEQPT EANVALALQDS - EKAS
PPMV       MCNTLGVDPLVAAKVMVAVVSNESGLTLT FERPT EANVALALQPTITSKE
TMGMV      MCKALDVSPDVAARVIVAVAENRSGLT LT FDKPTEENVAKALKSTASEAV
TMV - OB   MCAINCVPNDIAAKIVVAVLSNESGVTL PFKPT EGNMAEAMKSGEKDEV
ORSV       LCEEKDIAPDVLAKVIVPIMKNE -- LTL PFFNNPTPEALSDALSPLPKDL D
TVCV       LCQQKNVDPDMAAKVVVAIMKSE -- LTL PFKKPTEEEI SE SLKPGE GSCA
CR - TMV   LCQQKSVDPMMAAKVVVAIMKCE -- LTL PFKKPTEEEI SE SLKTGE G TSA
RMV - SH   LRQKKNVDPDMAAKVMVAIMNSE -- LTL PFKKPTEEEV AEALSGEVVQDE
CRMV       LCQQKNVDPDMAAKVVVAIMNSE -- LTL PFKKPTEEEV AEALSGEVVQDE

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TMV-CG      LCQKKNVDPDVAAKVVVAIM  --LTLPFKKPTEEEIAEALSGEVKQSE
CGMMV       FCKELNVNPMLIGHVIEAIFSQKAGVTVTGLGTLSPMGASVALSSTSVD
CGMMV-W     FCKELNVNPMLIGHVIEAIFSQKAGVTVTGLGTLSPMGASVALSNTSVD
CFMMV       FCHHHDVNPALVGPVIEAIFSQTAGITVTGLSTKSVEWAAAAEALAPTSVD
YCGMMV      FCHHHDVNPSLIGTVIEAIFSQSAGITVTGL----QAKSLEWAAAAEALAP
SHMV        YCEKLGVDIDTVTELIDAISTGRAGITLDHTDDKEEQLPRTLAGESSSYLE
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TMV-KR      EGALVVTSR-EVEEPSM
TMV-RAK     EGALVVTSR-EVEEPSM
TMV         EGALVVTSR-EVEEPSM
TOMV        DGALVVTSR-DVEEPSI
PPMV        EGSLKIVSS-DVGESSI
TMGMV       VCLEPTSEEVNVNKFSI
TMV-OB      LTLGSQTDNTDLTSKSM
ORSV        MRFSLKLSTCAPFPSV
TVCV        EHKEVLSLQNDAPFPCV
CR-TMV      EHKDVLSLQNDAPFPCV
RMV-SH      G----LSLSNNAFFPCV
CRMV        G----LRLSNKAPFPCV
TMV-CG      G----LSLSNNAFFPCV
CGMMV       TCEDMDVTEDMEDIVLM
CGMMV-W     TCEDMDVTEDMEDIVLM
CFMMV       MDCDSDEEELEQKFPNL
YCGMMV      VDDDMDCSSDEEDAAPH
SHMV        EEPsDDLVLCLSDKAIVN
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Appendix G

- D13367 Gb(84)_vi:MTVCP Tobacco mosaic virus CP gene. 7/94 474bp.
- D13438 Em(40)_vi:MTVGRNA Gb(84)_vi:MTVGRNA Tobacco mosaic virus genomic RNA. 12/93 6,507bp.
- D17458 Em(40)_vi:MTV30KP Gb(84)_vi:MTV30KP Tobacco mosaic virus (TMV) RNA for 30K protein, complete cds. 3/94 795bp.
- D38444 Em(44)_vi:Mtvcg Gb(90)_vi:Mtvcg Tobacco mosaic virus RNA. 10/94 6,303bp.
- J02412 Em(40)_vi:TO30KOM Gb(84)_vi:MTV30KOM tobacco mosaic virus 30k protein gene. 4/90 961bp.
- J02413 Em(40)_vi:TOC30KCP Gb(84)_vi:MTV30KCP tobacco mosaic virus(cowpea strain) 30k & coat protein genes. 4/90 1,800bp.
- J02415 Gb(84)_vi:MTVVCG Tobacco mosaic virus (strain vulgare), complete genome. 9/88 6,395bp.
- L11665 Em(40)_vi:MTVNGHYPE Gb(84)_vi:MTVNGHYPER Tobacco mosaic virus RNA. 8/93 6,506bp
- L35073 Gb(84)n:MTVCOATPRA Tobacco mosaic virus coat protein, complete cds. 8/94 678bp.
- L35074 Gb(84)n:MTVCOATPRO Tobacco mosaic virus coat protein, complete cds. 8/94 680bp.
- M19101 Em(40)_sy:AGVCHY Gb(84)_sy:SYNRMTVCHY Tobacco mosaic virus/calf chymosin recombined mRNA, promoter and 5' end. 7/89 101bp.
- M19102 Em(40)_sy:AGVLSZ Gb(84)_sy:SYNRMTVLSZ Tobacco mosaic virus/chicken lysozyme recombined mRNA, promoter and 5' end. 7/89 107bp
- M19103 Em(40)_sy:AGVCAT Gb(84)_sy:SYNRMTVCAT Tobacco mosaic virus/plasmid pJII2 chloramphenicol transferase recombined mRNA, leader and 5'
- M19104 Em(40)_sy:AGVNTP Gb(84)_sy:SYNRMTVNTP Tobacco mosaic virus/plasmid pJII3 neomycin phosphotransferase II recombined mRNA, leader and
- M19105 Em(40)_sy:AGVGUSA Gb(84)_sy:SYNVGUSA Tobacco mosaic virus/plasmid pJII119 beta-glucuronidase recombined mRNA, leader and 5' end. 7
- M19106 Em(40)_sy:AGVGUSB Gb(84)_sy:SYNVGUSB Tobacco mosaic virus/plasmid pJII139 beta-glucuronidase recombined mRNA, leader and 5' end. 7
- M24809 Em(40)_vi:TOBMTVGT Gb(84)_vi:MTVGTAMV tobacco mosaic virus RNA, 3' end. 2/90 72bp.
- M24955 Em(40)_vi:MTVU1RAA Gb(84)_vi:MTVU1RAA Tobacco mosaic virus (U1) omega RNA. 9/90 70bp.
- M24992 Gb(84)_vi:MTVU2RAA Tobacco mosaic virus (U2) omega RNA. 9/89 93bp.
- V01405 Em(40)_vi:TOTMV1 Gb(84)_vi:TOTMV1 Tobacco mosaic virus (TMV) RNA 5' coding region (nucleotides 69 to 236). 7/89 168bp.
- V01407 Em(40)_vi:TOTMV3 Gb(84)_vi:TOTMV3 Two tobacco mosaic virus genes (viral transport and coat protein). 9/93 961bp.
- V01408 Em(40)_vi:TOTMV4 Gb(84)_vi:TOTMV4 Tobacco mosaic virus genome (variant 1). 7/83 6,395bp
- V01409 Em(40)_vi:TOTMV5 Gb(84)_vi:TOTMV5 Tobacco mosaic virus genome (variant 2). 7/83 6,398bp.
- X00052 Em(40)_vi:TOTMV6 Gb(84)_vi:TOTMV6 Tobacco mosaic virus (TMV) common strain OM. 5'-terminal region. 6/85 275bp.
- X00053 Em(40)_vi:TOTMV7 Gb(84)_vi:TOTMV7 Tobacco mosaic virus tomato (TMV) strain L. 5'-terminal region. 6/85 278bp.

Appendix G (Continued)

- X02144 Em(40)_vi:TOTMV8 Gb(84)_vi:TOTMV8 Tobacco mosaic virus tomato strain (L) genome. 9/93 6,384bp.
- X66047 Em(40)_vi:TMV54KDA Gb(84)_vi:TMV54KDA Tobacco Mosaic Virus RNA for 54 kDa protein. 6/92 1,566bp.
- X68110 Em(40)_vi:TMVCG Gb(84)_vi:TMVCG Tobacco mosaic virus, complete genome. 10/92 6,395bp.
- X70882 Em(40)_vi:TMVPM2CP Gb(84)_vi:TMVPM2CP Tobacco mosaic virus PM2 mRNA for capsid protein. 7/93 765bp
- X70883 Em(40)_vi:TMVDT1CP Gb(84)_vi:TMVDT1CP Tobacco mosaic virus DT1 mRNA for capsid protein. 7/93 765bp.
- X70884 Em(40)_vi:TMVDT2CP Gb(84)_vi:TMVDT2CP Tobacco mosaic virus DT2 mRNA for capsid protein. 7/93 763bp.
- X70885 Em(40)_vi:TMVDT1GCP Gb(84)_vi:TMVDT1GCP Tobacco mosaic virus DT1G mRNA for capsid protein. 7/93 763bp.
- Z29370 Em(40)_vi:TMVRPTPCP Gb(84)_vi:TMVRPTPCP Tobacco mosaic virus (Crucifer) genomic RNA for RNA-dependent RNA polymerase; 122K protein.
- M25782 Em(43)_vi:Sllcp Gb(89)_vi:Sllcp Satellite tobacco mosaic virus coat protein RNA, complete cds. 11/94 1,058bp.

Appendix H

- J02001 Gb(84)_vi:MAARNA23 alfalfa mosaic virus (Q strain) rna2 3' end. 2/85 228bp.
- J02003 Em(40)_vi:ALRNA3 Gb(84)_vi:MAARNA3 alfalfa mosaic virus rna 3 35kd protein leader sequence. 4/90 318bp.
- J02005 Gb(84)_vi:MAARNA35 alfalfa mosaic virus (strain 425) rna3 5' end. 2/85 101bp.
- K02702 Gb(84)_vi:MAACG2Z Alfalfa mosaic virus (strain 425 Leiden) RNA 2 of complete genome. 9/88 2,593bp.
- K02703 Em(40)_vi:ALMRNA3 Gb(84)_vi:MAACG3Z Alfalfa mosaic virus (strain 425 Madison) RNA 3 of complete genome. 4/90 2,037bp
- K03542 Em(40)_vi:MAARNA3L Gb(84)_vi:MAARNA3L Alfalfa mosaic virus RNA 3 encoding viral coat protein, complete.B. 4/90 2,142bp.
- L00161 Gb(84)_vi:MAARNA33 Alfalfa mosaic virus (strain Q) RNA 3, 3' end. 8/86 230bp
- L00162 Em(40)_vi:ALMAARNA4 Gb(84)_vi:MAARNA4 Alfalfa mosaic virus (strain 425 Leiden) RNA 4 encoding viral coat protein. 5/94 964bp.
- L00163 Em(40)_vi:ALMAACG1Z Gb(84)_vi:MAACG1Z Alfalfa mosaic virus (strain 425 Leiden) RNA 1 of complete genome. 5/94 3,644bp.
- L00164 Gb(84)_vi:MAARNA13 Alfalfa mosaic virus (strain Q) RNA 1. 8/86 226bp.
- M10826 Em(40)_vi:MAARNA01 Gb(84)_vi:MAARNA4AX Alfalfa mosaic virus (AIMV) RNA 4, 3' terminal fragment 29C. 7/91 91bp.
- M10851 Em(40)_vi:MAARNA4A Gb(84)_vi:MAARNA4A Alfalfa mosaic virus RNA 4, 5' terminal region. 7/89 74bp.
- M25004 Em(40)_vi:ALMAARNAA Gb(84)_vi:MAARNAA Alfalfa mosaic virus RNA 3 or 4, 3' end. 4/92 113bp.
- M25005 Em(40)_vi:ALMAARNAB Gb(84)_vi:MAARNAB Alfalfa mosaic virus RNA 2, 3' end. 4/92 103bp.
- M25006 Em(40)_vi:ALMAARNAC Gb(84)_vi:MAARNAC Alfalfa mosaic virus RNA 1, 3' end. 4/92 110bp.
- M25452 Em(40)_vi:ALMAARNA1 Gb(84)_vi:MAARNA4D Alfalfa mosaic virus RNA 4 RNA fragment. 4/92 62bp.
- M35975 Em(40)_vi:ALMAARNA Gb(84)_vi:MAARNA1A Alfalfa mosaic virus (strain AIMV-S) 5' end of RNA-1. 12/90 163bp.
- M35976 Em(40)_vi:ALMAAR01 Gb(84)_vi:MAARNA1B Alfalfa mosaic virus (strain AIMV-B) 5' end of RNA-1. 12/90 115bp.
- M36389 Em(40)_vi:ALMAAR02 Gb(84)_vi:MAARNA2A Alfalfa mosaic virus (strain AIMV-S) 5' end of RNA-2. 12/90 108bp.
- M36390 Em(40)_vi:ALMAAR03 Gb(84)_vi:MAARNA2B Alfalfa mosaic virus (strain AIMV-B) 5' end of RNA-2. 12/90 109bp.
- M36391 Em(40)_vi:ALMAAR04 Gb(84)_vi:MAARNA3B Alfalfa mosaic virus (strain AIMV-S) 5' end of RNA-3. 12/90 305bp.
- M36392 Em(40)_vi:ALMAAR05 Gb(84)_vi:MAARNA3C Alfalfa mosaic virus (strain AIMV-B) 5' end of RNA-3. 12/90 290bp.

- M59241 Em(40)_vi:ALMAA32K Gb(84)_vi:MAA32KDMP Alfalfa mosaic virus 32 kDa movement protein and coat protein RNA, complete cds. 8/92 2,188bp.
- S55890 Em(40)_vi:S55890 Gb(84)_vi:S55890 RNA-3 coat protein homolog, alfalfa mosaic virus RNA-3 32K protein homolog (RNA-2) (raspberry bushy dwarf virus, Genomic RNA, 2231 nt).
- U12509 Em(43)_vi:Am12509 Gb(89)_vi:Amu12509 Alfalfa mosaic virus NZ1 RNA4 coat protein mRNA, complete cds. 8/94 876bp.
- U12510 Em(43)_vi:Am12510 Gb(89)_vi:Amu12510 Alfalfa mosaic virus NZ2 RNA4 coat protein mRNA, complete cds. 8/94 876bp.
- V00044 Em(40)_vi:ALALM1 Gb(84)_vi:ALALM1 5' end of alfalfa mosaic virus RNA 1. 5/94 61bp.
- V00045 Em(40)_vi:ALALM2 Gb(84)_vi:ALALM2 5' end of alfalfa mosaic virus RNA 2. 5/94 13bp.
- V00046 Em(40)_vi:ALALM3 Gb(84)_vi:ALALM3 5' end of alfalfa mosaic virus RNA 3. 5/94 101bp.
- V00047 Em(40)_vi:ALALM4 Gb(84)_vi:ALALM4 Intercistronic junction in alfalfa mosaic virus RNA 3. 5/94 122bp.
- V00048 Em(40)_vi:ALALM5 Gb(84)_vi:ALALM5 alfalfa mosaic virus RNA 4 coding for the coat protein. 5/94 881bp.
- V00049 Em(40)_vi:ALALM6 Gb(84)_vi:ALALM6 3' end of alfalfa mosaic virus RNA 1. 7/91 226bp.
- V00050 Em(40)_vi:ALALM7 Gb(84)_vi:ALALM7 3' end of alfalfa mosaic virus RNA 2. 7/91 228bp.
- V00051 Em(40)_vi:ALALM8 Gb(84)_vi:ALALM8 3' end of alfalfa mosaic virus RNA 3. 7/91 230bp.
- V00052 Em(40)_vi:ALAM01 Gb(84)_vi:ALAM01 Alfalfa mosaic virus RNA 1 fragment. (Obtained after digestion with ribonuclease T1.). 5/94 8
- V00053 Em(40)_vi:ALAM02 Gb(84)_vi:ALAM02 Alfalfa mosaic virus RNA 1 fragment. (Obtained after digestion with ribonuclease T1.). 5/94 6
- V00054 Em(40)_vi:ALAM03 Gb(84)_vi:ALAM03 Alfalfa mosaic virus RNA 1 fragment. (Obtained after digestion with ribonuclease T1.). 5/94 4
- V00055 Em(40)_vi:ALAM04 Gb(84)_vi:ALAM04 Alfalfa mosaic virus RNA 1 fragment. (Obtained after digestion with ribonuclease T1.). 5/94 4
- V00056 Em(40)_vi:ALAM05 Gb(84)_vi:ALAM05 Alfalfa mosaic virus RNA 1 fragment. (Obtained after digestion with ribonuclease T1.). 5/94 4
- V00057 Em(40)_vi:ALAM06 Gb(84)_vi:ALAM06 Alfalfa mosaic virus RNA 1 fragment. (Obtained after digestion with ribonuclease T1.). 5/94 3
- V00058 Em(40)_vi:ALAM07 Gb(84)_vi:ALAM07 Alfalfa mosaic virus RNA 1 fragment. (Obtained after digestion with ribonuclease T1.). 5/94 3
- V00059 Em(40)_vi:ALAM08 Gb(84)_vi:ALAM08 Alfalfa mosaic virus RNA 1 fragment. (Obtained after digestion with ribonuclease T1.). 5/94 3
- V00060 Em(40)_vi:ALAM09 Gb(84)_vi:ALAM09 Alfalfa mosaic virus RNA 1 fragment. (Obtained after digestion with ribonuclease T1.). 5/94 2
- V00061 Em(40)_vi:ALAM10 Gb(84)_vi:ALAM10 Alfalfa mosaic virus RNA 1 fragment. (Obtained after digestion with ribonuclease T1.). 5/94 2

- V00062 Em(40)_vi:ALAM11 Gb(84)_vi:ALAM11 Alfalfa mosaic virus RNA 1 fragment. (Obtained after digestion with ribonuclease A.). 5/94 25
- V00063 Em(40)_vi:ALAM12 Gb(84)_vi:ALAM12 Alfalfa mosaic virus RNA 1 fragment. (Obtained after digestion with ribonuclease A.). 5/94 19
- V00064 Em(40)_vi:ALAM13 Gb(84)_vi:ALAM13 Alfalfa mosaic virus RNA 1 fragment. (Obtained after digestion with ribonuclease A.). 5/94 19
- V00065 Em(40)_vi:ALAM14 Gb(84)_vi:ALAM14 Alfalfa mosaic virus RNA 1 fragment. (Obtained after digestion with ribonuclease A.). 5/94 18
- V00066 Em(40)_vi:ALAM15 Gb(84)_vi:ALAM15 Alfalfa mosaic virus RNA 1 fragment. (Obtained after digestion with ribonuclease A.). 5/94 18
- V00067 Em(40)_vi:ALAM16 Gb(84)_vi:ALAM16 Alfalfa mosaic virus RNA 1 fragment. (Obtained after digestion with ribonuclease A.). 5/94 15
- V00068 Em(40)_vi:ALAM17 Gb(84)_vi:ALAM17 Alfalfa mosaic virus RNA 1 fragment. (Obtained after digestion with ribonuclease T1.). 5/94 9
- X00819 Em(40)_vi:ALAM19 Gb(84)_vi:ALAM19 Alfalfa mosaic virus (strain S) complete RNA 3 sequence. 9/93 2,055bp.
- X01572 Em(40)_vi:A1MVRNA2 Gb(84)_vi:A1MVRNA2 Alfalfa mosaic virus (A1M4) RNA 2. 7/91 2,593bp.
- M28374 Em(43)_vi:Maatbts7a Gb(89)_vi:Maatbts7a Alfalfa mosaic virus (clone 143) temperature-sensitive mutant Tbts7 RNA3 (coat protein-encoding)
- M28375 Em(43)_vi:Maatbts7b Gb(89)_vi:Maatbts7b Alfalfa mosaic virus (clone 112) temperature-sensitive mutant Tbts7 RNA3 (coat protein-encoding), 5' end fragment.

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